Work related musculoskeletal disorders of the neck and upper limb

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MBBS, MPH, MPH(OH), MEng(SHE)

Submitted in total fulfilment of the requirement of the degree of Doctor of Philosophy

Monash University Faculty of Medicine, Nursing and Health Sciences

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November 2011
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Summary

Work-related musculoskeletal disorders of the neck and upper limb (WRULDs) are an important concern in the workplace and a costly healthcare problem. WRULDs remain one of the most common occupational illnesses in Western countries.

This thesis focuses on two important aspects of WRULDs: the first is the identification of risk factors associated with WRULDs among nurses, in particular neck, shoulder and hand or wrists pain, and their relationship with nurses’ perceived work ability, and the second is the conduct of a Cochrane systematic review to investigate interventions for the prevention of WRULDs.

The first publication looks at a novel approach to identifying the risk of neck and shoulder pain in hospital-based nurses. The pain at individual sites; i.e., neck pain alone, shoulder pain alone, and neck and shoulder pain, were individually compared with those reporting no neck or shoulder pain, allowing the risk factors for the individual sites to be estimated. The second paper looks at risk factors for wrist or hand pain among nurses. Although the wrist and hand functions are important in both activities of daily living and work function, especially among nurses, the research on wrist or hand pain is limited compared to the body of research on pain in other sites of the body. The third paper investigates the relationship between multisite musculoskeletal pain and reduced work ability among nurses. Work ability is a measure of a worker’s capacity to perform their work based on the work content and job demand.

The fourth and fifth papers consist of the Cochrane protocol and systematic review investigating the ergonomic design and training for the prevention of work-related musculoskeletal disorders of the upper limb and neck in adults.
The first part of the thesis found that the risk factors for neck pain alone, shoulder pain alone, and neck and shoulder pain together were different. Somatisation tendency, health beliefs and mental and physical health and wellbeing were associated with neck and shoulder pain, whereas neck pain alone was more consistently associated with demographic and anthropometric factors, and shoulder pain alone with health beliefs. Wrist and hand pain was found to be prevalent in hospital nurses, and to be associated with both physical and psychosocial factors, including somatisation tendency. Musculoskeletal pain in one or more anatomical sites was found to predict reduced self-perceived work ability, with work ability reducing as the number of painful sites increased. Preventing musculoskeletal disorders among nurses should be set as a priority, and besides focusing on ergonomic factors, psychosocial factors also need to be considered in interventions.

The Cochrane systematic review demonstrated moderate quality evidence that the use of an alternative mouse with an arm support board for VDU users was effective in reducing the incidence of neck/shoulder disorders but there was only low quality evidence in reducing symptoms of upper limb and neck/shoulder discomfort. There was also very low to moderate quality evidence that the other ergonomic intervention did not demonstrate any benefit in terms of preventing WRULDs. The findings have important implications for determining ergonomic interventions and education to be implemented in occupational settings in the prevention of work-related musculoskeletal disorders of the neck and upper limb.
Candidate’s General Declaration

In accordance with Monash University Doctorate Regulation 17/ Doctor of Philosophy and Master of Philosophy (MPhil) regulations the following declarations are made:

I hereby declare that this thesis contains no material which has been accepted for the award of any other degree or diploma at any university or equivalent institution and that, to the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

This thesis includes two original papers published in peer reviewed journals and three unpublished publications. The core theme of the thesis is Work related musculoskeletal disorders of the neck and upper-limb. The ideas, development and writing up of all the papers in the thesis were the principal responsibility of myself, the candidate, working within the Monash University Department of Epidemiology and Preventive Medicine under the supervision of Professor Malcolm Sim, and co-supervisors Dr Helen Kelsall and Dr Donna Urquhart.

The inclusion of co-authors reflects the fact that the work came from active collaboration between researchers and acknowledges input into team-based research.

In the case of the following chapters my contribution to the work involved the following:

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<td>2.</td>
<td>Hoe, V. C. W., Kelsall, H. L., Urquhart, D. M. &amp; Sim, M. R. 2012. Risk factors for musculoskeletal symptoms of the neck or shoulder alone or neck and shoulder among hospital nurses. <em>Occupational and Environmental Medicine</em>, 69, 198-204.</td>
<td>Published</td>
<td>Principal author: Responsible for overall concept and design; development of the study design, methods and questionnaire; data collection; data cleaning; literature review; analysis; development and drafting of the submitted manuscript, and critical revision of the manuscript. Responsible author who accepts overall responsibility for the publication. (Extent of contribution 80%)</td>
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<td>3.</td>
<td>Surawera, I. K., Hoe, V. C. W., Kelsall, H. L., Urquhart, D. M. &amp; Sim, M. R. Prevalence and physical and psychosocial factors associated with wrist or hand pain among Australian hospital-based nurses. <em>Injury Prevention</em>, Epub 17 May 2012.doi 10.1136/injuryprev-2011-040267</td>
<td>Published</td>
<td>Co-principal author: Responsible for development of the questionnaire; methods and data collection; data cleaning; literature review; analysis; drafting of the submitted manuscript, and critical revision of the manuscript. (Extent of contribution 40%)</td>
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<td>4.</td>
<td>Hoe VCW, Kelsall HL, Urquhart DM, Sim MR. A prospective study of work ability and multiple sites musculoskeletal pain among female hospital based nurses. <em>Scandinavian Journal of Work Environment and Health.</em></td>
<td>Submitted</td>
<td>Principal author: Responsible for overall concept and design; development of the questionnaire; data collection; data cleaning; literature review; analysis; development and drafting of the submitted manuscript, and critical revision of the manuscript. Responsible author who accepts overall responsibility for the publication. (Extent of contribution 80%)</td>
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<td>Hoe VCW, Kelsall HL, Urquhart DM, Sim MR. Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults (Protocol). Cochrane Database of Systematic Reviews 2010, Issue 7. Art. No.: CD008570. DOI: 10.1002/14651858.CD008570.</td>
<td>Published</td>
<td>Principal author. Responsible for initiating the systematic review; establishing contacts with Cochrane Review Groups, developing and drafting the submitted protocol, developing the search strategy, critical revision of the protocol. Responsible author who accepts overall responsibility for the protocol. (Extent of contribution 80%)</td>
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<td>6.</td>
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<td>Published</td>
<td>Principal author: Responsible for initiating and planning the systematic review, administering the review process, liaison with the Cochrane Review Groups including during a period of transition; communication with the Australasian Cochrane Centre to clarify requirements and undergo training; participating in the decision-making process regarding the inclusion and exclusion of the studies; data extraction; risk of bias assessment; data synthesis; analysis; GRADE quality assessment; developing and drafting and critical revision of the manuscript, overall interpretation. Responsible author who accepts overall responsibility for the systematic review and for updating the review every two years. (Extent of contribution 80%)</td>
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[* For example, ‘published’/ ‘in press’/ ‘accepted’/ ‘returned for revision’]

I have renumbered sections of submitted or published papers in order to generate a consistent presentation within the thesis.
Acknowledgements

A special thanks to my supervisors Professor Malcolm Sim, Dr Helen Kelsall and Dr Donna Urquhart for supporting my adventure in to the realm of the abyss and guided me to road of discovery. I am eternally grateful to Malcolm, first for agreeing to take on the risk, and for always keeping me in focus, for the guidance in the art of journal writing, and for providing the opportunity and support to present my research findings at conferences in Sydney, Bangkok and Oxford. I would like to thank Helen for listening to all my grievances, correcting my English, guiding me through ‘V’ drive, being organised, and finally sharing her family with mine. I would also like to thank Donna, who has been great at keeping everything succinct and giving timely comment.

Thanks to Rory Wolfe and Stella Gwini for assistance with numbers; Vanessa Murray, Jane Miosge and Emily Mulholland for creative administrative support; Anthony Del Monaco and David Khuu for assistance in the IT maze; Dr Ewan MacFarlane and Dr Dean McKenzie for the lighter side of MonCOEH; Christina Dimitriadis for contacting the missing; Mina Roberts for extracting the data; Professor Michael Abramson and Dr Robert Hall for supporting my moonlighting activities; Dr Elizabeth Douglas and Associate Professor Rory Wolfe for post graduate support; all other staff from MonCOEH for helping in the mail out; and all PhD colleagues for being there.

One part of the research in my thesis was undertaken as part of an international collaboration. I would like to acknowledge the assistance from CUPID international study team, led by Professors David Coggon and Keith Palmer, and a group based at the Medical Research Council Epidemiology Resource Centre, University of Southampton; thanks to Mandy Sandford, Tarryn McConnell, Collen Gloury, and Vicky White from the Alfred Health
nursing team for their assistance in the recruitment process; and all the participant of the Australia Nurses’ Work and Health Study. The other part of the research was the Cochrane Systematic Review, I would like to acknowledge Dr Helen Handoll, Lindsey Elstub, and Lesley Gillespie from the Cochrane Bone, Joint and Muscle Trauma Group; Professor Jos Verbeek, Jani Ruotsalainen and Leena Isotalo form the Cochrane Occupational Safety and Health review group; and Miranda Cupston and Jo McKenzie from the Australasian Cochrane Centre for their assistance.

I am grateful to acknowledge the financial supports provided by the Ministry of Higher Education’s Academic Training Scheme, Malaysia and University of Malaya, which has enable me to complete this endeavour; and Monash University Postgraduate Travel Grants and DEPM, which enable me to attend conferences.

Thanks to Dr Hamidah Abdul Karim who had guided me through my first research; Dr Ling Kin Hong who had introduce me to the field of Occupational Health; Associate Professor S Noor Ghani for encouraging me to join the Department of SPM and keeping up my hope of starting PhD; Professor Awang Bulgiba as the Head of Department for supporting my application; and Professor Ikram Shah as the Dean of Faculty of Medicine for approving the application.

Finally I would like to thank our dear friends Karen and David Cheah, for taking us in when we first arrive; Su and Damien Stanyer for arranging our home, my parents, Bobby and Judy for their encouragement in all my endeavours, and my family, Wan, Natasha and Daniel for joining me here in Australia. Without their love, support and encouragement, this journey would have been more difficult.
Publications and Presentations

The following publication and presentations were produced during the development of this thesis:

Published articles


Articles in press


Submitted articles


Conference Presentations


Invited presentation

## Abbreviations and Acronyms

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<th>Abbreviation</th>
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<tr>
<td>ANFV</td>
<td>Australian Nursing Federation (Victorian Branch)</td>
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<td>BJMT</td>
<td>Bone, Joint and Muscle Trauma</td>
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<td>BMI</td>
<td>Body-mass index</td>
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<td>CANS</td>
<td>Complaints of the arm, neck and/or shoulder</td>
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<td>CUPID</td>
<td>International Survey of Physical, Cultural and Psychological Influences on Musculoskeletal Symptoms and Associated Disability</td>
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<tr>
<td>GRADE</td>
<td>Grading of Recommendations Assessment, Development and Evaluation</td>
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<td>OHF</td>
<td>Occupational Health Field</td>
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<td>OSH</td>
<td>Occupational Safety and Health</td>
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<td>MRC</td>
<td>Medical Research Council, United Kingdom</td>
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<td>MSDs</td>
<td>Musculoskeletal Disorders</td>
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<td>RSI</td>
<td>Repetitive strain injury</td>
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<td>UEDs</td>
<td>Upper extremity disorders</td>
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<td>VNBIPP</td>
<td>Victorian Nurse Back Injury Prevention Project</td>
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<td>WRULDs</td>
<td>Work-related upper limb disorders</td>
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1. Introduction

Work-related upper limb musculoskeletal disorders (WRULDs) continue to be an important concern in the workplace and are also a costly healthcare problem. These have been recognised as a problem since the 17th century, when first described among professional writers (Ramazzini, 1964) and again in the 20th century among musicians (Fry, 1986a). Although these disorders are not new, they have been steadily increasing during the past few decades especially among industrialised nations (Yassi, 1997) and there are still many gaps in our understanding of what factors increase their risk and the best ways to reduce their impact.

What are WRULDs?

Musculoskeletal disorders (MSDs) of the upper limbs include disorders of the shoulders, upper arms, elbows, forearms, wrists and hands (Buckle and Devereux, 1999). It does not define the pathological mechanism, nor the diagnostic criteria but encompasses a range of conditions affecting the joints, muscles, tendons, ligaments, supporting blood vessels and nerves of the neck and upper limbs (Sleator et al., 1998, Punnett and Wegman, 2004). WRULDs are MSDs of the neck and upper limbs contributed to by exposure to risk factors at the workplace. They can be divided into specific conditions with clear diagnostic criteria and pathological findings, which include tendon-related disorders (e.g. tendonitis), peripheral-nerve entrapment (e.g. carpal tunnel syndrome), neurovascular/vascular disorders (e.g. hand-arm vibration syndrome) and joint/joint-capsule disorders (e.g. osteoarthritis), or non-specific conditions where the main complaint is pain and/or tenderness with limited or no physical findings, which include chronic pain syndromes (Buckle, 1997, Yassi, 1997, Boocock et al., 2009, Punnett and Wegman, 2004, Coggon et al., 2000).
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**Terminology used to classification WRULDs**

WRULDs have been known by many other terms, which include occupational cramp, writer’s cramp, musician’s cramp and telegraphist’s cramp based on occupational groups (Ramazzini, 1964, Fry, 1986a, Sleator et al., 1998); and repetitive strain injury, occupational overuse syndrome and cumulative trauma disorders based on possible mechanism of injury (Fry, 1986b, Yassi, 1997, Huisstede et al., 2006). Since the disorders are known to affect a wide variety of occupational groups and may be due to various risk factors (Palmer et al., 2001), some researchers have used terms based on the sites of disorders; e.g. upper extremity disorders (UEDs), work-related upper extremity disorders (WRUEDs), upper extremity problems (UEP) and complaints of the arms, neck and/or shoulder (CANS) (Huisstede et al., 2006, Huang et al., 2002, Bongers et al., 2002, Huisstede et al., 2007).

Furthermore different systems have been used to classify upper-limb MSDs in workers, Van Eerd et al. found 27 different classification systems (Van Eerd et al., 2003) New classifications systems are still being proposed, as shown by two recent studies. Beaton et al. have proposed the triaxial classification systems for MSDs based on the presence of symptoms, signs and specific diagnosis (Beaton et al., 2007) and Boocock et al. have proposed a dynamic model for classifying work-related upper-extremity conditions which places greater emphasis on specific diagnoses (Boocock et al., 2009). The differing terminology and lack of clear case definitions have hindered efforts in the estimation of disease burden, prevention and management of these disorders (Sleator et al., 1998, WHO, 2003, Yassi, 1997).
Chapter 1

**Impact of WRULDs**

Before considering the impact of WRULDs, it is important to recognise that MSDs of the neck and upper limb are common in the community. The one-month prevalence of MSDs of the neck and upper limbs in the community ranged from 7 to 47% (Urwin et al., 1998, Eriksen et al., 1998, Bergenudd et al., 1988, Webb et al., 2003, Fejer et al., 2006) and the one-year prevalence ranged from 8 to 75% (Fernandez-de-las-Penas et al., 2011, Lau et al., 1996, Lock et al., 1999, Fejer et al., 2006, NWAHS, 2009). It is also important to note that community prevalence of MSDs in adults includes both working and non-working population; i.e. the unemployed, retired, sick-listed, housewives and students.

The true impact of WRULDs is difficult to estimate because of the differing terminologies and classification systems. Most of the reports and estimates of the impact of WRULDs includes other sites of MSDs, for example low back and lower limbs. Globally, MSDs are a leading cause of morbidity, giving rise to enormous healthcare expenditures and early departure from work (WHO, 2003). In the Forth European Working Conditions Survey across 31 countries in Europe, MSDs were the most frequently reported work-related health problems and accounted for more than 48% of the reported cases, with 25% reporting backache and 23% reporting other muscular pain (Parent-Thirion et al., 2007). Work-related MSDs remain one of the most commonly reported illnesses in the United Kingdom, with the estimated prevalence rate of 1,910 per 100,000 workers for all MSDs, 839 per 100,000 workers for MSDs mainly affecting the back, 770 per 100,000 workers for MSDs mainly affecting the upper limbs or neck, and 320 per 100,000 workers for MSDs mainly affecting the lower limbs (HSE, 2009/10, HSE, 2010).
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In the United States, work-related MSDs accounted for up to 29% of all workplace injuries and illnesses requiring time away from work in 2010, with an incidence rate of 34 per 10,000 full-time workers, which was an increase of 4% from 33 per 10,000 in 2009 (BLS, 2011). MSDs of the shoulder, arm and wrist accounted for 15%, 5% and 6% of all MSDs respectively. Although MSDs of the shoulder only account for 15% of the MSDs cases, it was the most severe MSDs, requiring a median of 21 days away from work (BLS, 2011). In Australia work-related MSDs constitute 43% of all injury and disease related workers’ compensation claims (Miller et al., 2006) and accounted for 54% of all WorkCover claims in the state of Victoria (WorkSafe-Victoria, 2008). Work-related MSDs are also the most common work-related problem managed by general practitioners in Australia and the most common sites were back (42%), followed by upper limb (20%), lower limb (11%) and neck (7%) (NOHSC, 2001).

Work-related MSDs, and WRULDs in particular, contribute a major component to the cost of work-related illness. The estimated cost of WRULDs was between 0.5% and 2% of gross national products in Nordic countries, and £1.25 billion in the United Kingdom (Buckle and Devereux, 1999). In the United Kingdom, MSDs were the second most common reason for sickness certificates, with 23 sickness certificates per 1000 person years (Wynne-Jones et al., 2009). In the United States, 52% of the total loss of work days were due to MSDs (USBID, 2008), and in Sweden WRULDs constituted 15% of all sick-leave days and 18% of all sickness pensions in 1994 (Buckle and Devereux, 1999). In Australia, disorders of the muscles, tendons and soft tissue (excluding back pain) were estimated to cost AUD519 million or 17% of the total health system costs in 1993 and 1994 (Mathers and Penm, 1999).
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The prevalence of WRULDs varies considerably across occupations and working populations. According to a review of epidemiological studies the point prevalence of upper-extremity MSDs in workers ranged from 27% to 47%, and the 12-month prevalence ranged from 12% to 41% worldwide (Huisstede et al., 2006). The annual prevalence of neck pain in the working population ranges from 17% to 74% (Cote et al., 2008).

Health care workers, especially nurses, are particularly at risk of developing WRULDs which is consistent with the often heavy nature of nursing work, such as lifting patients (Fronteira and Ferrinho, 2011). In Victoria, Australia, MSDs injuries in the health sectors accounted for approximately 8.5% of all claims within the WorkCover Scheme in 2006/07 and the MSDs accounted for the highest proportion of claims among the health sectors (71.2%) compared to claims from other industries (54.8%) (WorkSafe-Victoria, 2007). The most common WRULDs among nurses relate to the shoulder, with prevalences of 12-61% and the neck (23-52%), while those in the arm, elbow, wrist and hand are less common (2-24%) (Ahlberg-Hulten et al., 1995, Lagerström et al., 1995, Engels et al., 1996, Josephson et al., 1997, Ando et al., 2000, Trinkoff et al., 2002, Smith et al., 2003, Tezel, 2005, Alexopoulos et al., 2006, Harcombe et al., 2009). The prevalence of neck pain among nurses is comparable to those among other high risk occupational groups such as office workers (17-63%), and to workers in manual occupations which ranges from 17% among spinning industry production line workers to 74% in crane operators (Cote et al., 2008).

Reasons for the wide variance in the reported prevalence of WRULDs include the absence of a universally accepted definition and the use of different diagnostic criteria (e.g. self-reported or medical examination) (Buckle and Devereux, 1999, Huisstede et al., 2006).
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Risk factors for WRULDs

The risks for WRULDs include individual and workplace factors with work factors including physical, organisational and psychosocial factors (Marras et al., 2009, NIOSH, 2001, Shanahan and Jezukaitis, 2006). The workplace physical factors consists of awkward posture, heavy physical work, repetitive work and the use of vibrating tools (da Costa and Vieira, 2010), workplace organisational and psychosocial factors which include work-rest cycle, shift work, job dissatisfaction, job stress and social support (Ariens et al., 2001). Epidemiological studies have indicated that between 11% and 95% of upper extremity injuries are contributed to by workplace physical factors and 28-84% are contributed to by psychosocial factors at work (Marras et al., 2009). However, several reviews have found that the effects of these factors were not consistent and the associations were generally not strong (Cote et al., 2008, Palmer and Smedley, 2007, van der Windt et al., 2000, Ariens et al., 2001).

Individual factors such as female gender, mental distress and low physical capacity seem to have a stronger role than workplace factors in the development of WRULDs (Cote et al., 2008, Palmer and Smedley, 2007). However these identified personal risk factors are not the only ones which can contribute to the development of WRULDs. There is preliminary evidence to suggest that other personal factors like somatisation, coping strategies, cultural factors, perceptions, expectation and beliefs could be risk factors for MSD, including WRULDs (Macfarlane et al., 2000, Palmer et al., 2005, Madan et al., 2008).

Somatisation tendency is linked to heightened awareness of somatic symptoms and a tendency to attribute such symptoms to physical illness (Barsky et al., 1988). The tendency to amplify a broad range of bodily sensations may therefore be an important factor in experiencing and reporting WRULDs. Some studies have found that somatisation tendency can be associated with chronic widespread pain (Palmer et al., 2005, McBeth et al., 2001).
Somatisation has also been implicated as a factor in the transition to chronic low back pain (Pincus et al., 2002).

Pain castrophising is the expression of worry and excessive focus on negative aspects of painful situations, expectations of negative outcomes and the inability to cope effectively with pain (Sullivan et al., 1995). Pain castrophising had been found to be associated with the development back pain and quality of life of people with chronic back pain. Pain castrophising showed the strongest association with quality of life in chronic pain patients, and was even stronger than pain intensity (Lame et al., 2004). In a prospective study on a general working population those without back pain at baseline were followed up for 12 months and those experiencing pain castrophising had the highest odds of developing significant pain at follow-up (Linton, 2005). However, the effects of somatisation tendency and pain castrophising on WRULDs are still unclear. As WRULDs have some similarities to work-related low back pain it may be influenced in a similar way by these factors.

These personal factors, in combination with the other work and non-work factors, could be important in determining the development and persistence of WRULDs (Coggon, 2005, Huang et al., 2002, Burton et al., 2009).

**Natural history of WRULDs**

The consequences of an injury to the neck and upper limb may or may not lead to pain and disability. It depends on the severity of the injury and the individual reaction towards the injury. As noted by Visser and van Dieen, the injury that leads to tissue damage may not necessary lead to symptoms (Visser and van Dieën, 2006). In some cases of WRULDs there is clearly identifiable underlying pathology (e.g. nerve-root compression in the carpal tunnel of the wrist), however the presence of underlying pathology does not rule out an important
contribution of psychological variables to the clinical course of a disorder and the level of associated disability. The absence of underlying organic pathology also does not preclude the occurrence of objective physical abnormalities in association with an MSD. For example, reduced use of a limb because it is painful could lead to loss of muscle and increased weakness. Disorders that do not result from organic pathology will tend to have different causes and to respond differently to treatment from disorders produced by direct injury to tissues (Coggon, 2005). Further, a clear distinction should be made between the presence of symptoms, reporting of symptoms, attribution of symptoms to work, seeking healthcare, persistence of symptoms, and disability as they may have different determinants (Burton et al., 2009).

Health beliefs and other personal characteristics may have a greater influence on the persistence of symptoms and levels of associated disability than on the occurrence of acute and transient illness (Grotle et al., 2006). In a longitudinal study of adults from the general UK population, negative beliefs about the prognosis of musculoskeletal symptoms were predictive of their persistence (Palmer et al., 2007). Early recognition of the role of non-organic risk factors, such as health beliefs and other personal characteristics in the development and persistence of WRULDs is essential to avoid excessive diagnostic testing as well as inappropriate medical and surgical intervention (Coggon, 2005, NRC, 2001).

**Workforce retention**

Identifying the risk factors for, and interventions to reduce, WRULDs are likely to be important in workforce retention. This is likely to be a greater problem in those industries where there are existing shortages in trained personnel, such as for the nursing or technical workforce (e.g., plumbers, electrician, and construction workers).
Currently, many developed countries are experiencing nursing shortages (such as the United States of America, Europe and Australia) and it is predicted that this situation will deteriorate further in the future (Goodin, 2003, AIHW, 2005). With the population ageing there has been an increase in the number of older individuals both in absolute number and proportion, which is further exacerbating the situation, as there is an increased need to care for an ageing population by an ageing nursing workforce (UN, 2001).

A longitudinal study among Swedish nursing personnel found that nurses reporting musculoskeletal problems of the neck/shoulder or knees and those who had limited use of transfer devices were more likely to leave nursing care (Fochsen et al., 2006). Another key reason for nurses leaving the profession has been found to be low perceived work ability (Camerino et al., 2006). Work ability is a measure of a worker’s capacity to perform their work based on the work content and job demand (Ilmarinen and Tuomi, 1992). Furthermore, a recent cross-sectional study found that multisite MSDs were associated with poor work ability in the Finnish general working population (Miranda et al., 2010). Similar findings were also observed among industrial workers, where multi-site musculoskeletal pain at baseline strongly predicted poor work ability four years later (Neupane et al., 2011).

**Conceptual models**

As discussed above there are many types of factors which have been shown to influence the development of WRULDs and other work-related MSDs. Many conceptual models to describe the possible roles of various contributing factors to the development of WRULDs have been proposed. Huang et al (Huang et al., 2002) have summarised these into four possible scenarios;
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- workplace factors can influence musculoskeletal outcomes by directly affecting ergonomic exposures and biomechanical loads,

- workplace factors may contribute to physiological, psychological, and behavioural stress responses that may impact on the relationship between ergonomic exposures and musculoskeletal outcomes,

- exposure to occupational stress can independently exert a direct effect on symptom expression, and

- individual factors, such as ability to cope and personality may interact with workplace organisational factors and serve as co-determinants of stress responses and their effects on WRULDs (Huang et al., 2002).

Huang et al. (Huang et al., 2002) also noted that most of the models have not been substantiated. From the models described it is noted that a single model does not adequately explain the temporal changes that have been observed in the disability attributed to such disorders. For example, in Australia there was a major epidemic of disability from arm pain during the early 1980s that was not paralleled in other countries where similar technologies and working methods were employed (Gun, 1990, Hocking, 1987). A similar trend was also observed in the UK, where there was an increase in the rate of back pain between the 1950’s and 1990’s although physical demands decreased over that period (Coggon, 2005, Palmer et al., 2000). The most probable scenario would be that all these models interact with each other and contribute to the development and reporting of MSDs. The proposed conceptual models developed for this thesis, as depicted in Figures i, may be more appropriate in describing the development, reporting and the natural history of work-related MSDs, including WRULDs. The model depicts that both individual and workplace factors can have influence at each step...
in the progression of WRULDs from injury to disability and finally to the worker ceasing working.

Figure i: Conceptual model to describe the possible relationship between risk factors and WRULDs.
Chapter 1

**Prevention of WRULDs**

For the prevention of WRULDs there is a need to understand the epidemiology and risk factors of the disorders. WRULDs, especially the non-specific disorders, are largely self-healing (WHO, 2003, Burton et al., 2009, Coggon et al., 2000). As the traditional epidemiological models may not apply to these musculoskeletal conditions, a more inclusive biopsychosocial model may be more appropriate (Burton et al., 2009, WHO, 2003, Coggon et al., 2000). Biopsychosocial models refer to the concept that biological, psychological and social factors combine in an interlinked system which contributes to human functioning and development of disorders and diseases (Burton et al., 2008). The ‘host’ in the traditional epidemiological model can be expanded to include psychological and social factors. Although the use of a biopsychosocial model for the prevention of WRULDs may show considerable promise (Burton et al., 2009), interventions based on this model often requires substantial financial resources (Karjalainen et al., 2003). In addition, there is a lack of evidence of the effectiveness of interventions based on a biopsychosocial model, as concluded by a Cochrane Systematic Review (Karjalainen et al., 2003).
Chapter 1

**Overall Objective**

The overall objectives of this thesis are two-fold; to investigate the role of risk factors identified in the proposed model in the development of WRULDs in a high risk occupational group, hospital based nurses, where WRULDs are common and to identify the strength of the existing scientific evidence regarding the use of ergonomic interventions in preventing WRULDs in occupational groups.

**Specific objectives**

1. To investigate physical, psychological and other factors associated with work-related neck and upper limb pain in nurses.

2. To investigate the relationship between work ability and WRULDs in nurses.

3. To investigate the effectiveness of ergonomic interventions in preventing WRULDs through a Cochrane Systematic Review.

**Outline of Thesis**

The thesis consists of two distinct components focusing on important and related, aspects of WRULDs; one related to original research investigating risk factors in a specific high risk occupational group and the other systematically reviewing and conducting meta-analyses of evidence for ergonomic interventions across occupational groups which are the subject of published studies but on an aspect of WRULDs for which there is a gap in the Cochrane Systematic Review literature.

The first part of the thesis focuses on identifying the psychosocial, personal and other risk factors for WRULDs and work ability among hospital based nurses, a high risk occupational
Chapter 1

group, in Melbourne, Australia. This part of the thesis relates to The Australian Nurses’ Work and Health Study, which was part of, but extended, the Australian arm of the International Study of Physical, Cultural and Psychosocial Influences on Musculoskeletal Symptoms and Associated Disability (CUPID Study) (Coggon et al., 2012), which is an international multicentre study involving 18 countries.

The first part of the thesis addressing Objectives 1 and 2 consists of two first-author and one co-first author published or submitted papers (Chapters 2-4), each of which reports the introduction, methods, results and discussion. Chapter 2 is a published journal article (Hoe et al., 2012) of a cross-sectional analysis which aimed to identify the factors associated with musculoskeletal pain of the neck or shoulder alone or neck and shoulder together among hospital based nurses. The paper aimed to assess the factors associated with each site of pain separately, as earlier studies of healthcare workers have found that risk factors for MSDs differed between body sites. Chapter 3 is a published co-first author journal article (Surawera et al., 2012) which aimed to identify the physical and psychosocial factors associated with musculoskeletal pain of the wrist or hand among hospital based nurses. Chapter 4 is a first-author submitted journal article which aimed to identify the relationship between multiple sites of musculoskeletal pain and work ability, an area in which there has been very little previous research.

The second part of the thesis addressing Objective 3 is a Cochrane Systematic Review on WRULD Intervention Studies entitled “Ergonomic design and training for preventing work-related MSDs of the upper limb and neck in adults”. I selected this topic as the focus for preventing WRULDs as an earlier study on the ‘No-lifting’ intervention policy had shown that an ergonomic intervention was successful in reducing both the injury claim rate and work days lost for low back injury, but had no effect on neck/shoulder and wrist/knee/ankle claims
Chapter 1

(DHSV, 2004). It was therefore considered important to address this gap for WRULDs and review other similar studies assessing ergonomic interventions for preventing WRULDs. The second part of the thesis consists of two first-author published or accepted articles (Chapters 5 and 6). Chapter 5 is a peer-reviewed Cochrane protocol published in The Cochrane Library (Hoe Victor et al., 2010). Chapter 6 is the subsequent Cochrane systematic review, including several meta-analyses, which consists of the conduct, results and findings of the systematic review, and which has been reviewed by the Cochrane Occupational Health Review Group and published in The Cochrane Library (Hoe Victor et al., 2012).

Chapter 7 is a concluding chapter which discusses the implications of the overall research findings in this thesis. This chapter expands upon the discussion presented in each individual published or submitted paper and aims to synthesise the research findings, identify the common themes, identify implications for practice and policy and areas for further research.
Chapter 2

2. Risk factors for musculoskeletal symptoms of the neck or shoulder alone or neck and shoulder among hospital nurses.

2.1 Introduction

**Australian Nurses’ Work and Health Study**

Chapters 2 to 4 are part of the Australian Nurses’ Work and Health Study. It is a 12 month prospective study investigating factors associated with the development and persistence of musculoskeletal pain. This study was also part of the Australian arm of the CUPID study (Coggon et al., 2012), an international multicountry prospective study of MSDs in three different occupational groups, including nurses.

The study population of the Australian Nurses’ Work and Health Study consisted of nurses working for AlfredHealth across three public hospitals in Melbourne, Australia. The hospitals were The Alfred, a tertiary referral and teaching hospital; Caulfield Hospital, a hospital providing mainly rehabilitation and aged care services; and Sandringham Hospital, a community based hospital. The three hospitals were chosen as it included nurses having different types of work tasks and demographic profile. The Alfred consists of more acute care wards and the nurses were younger as compared to Caulfield Hospital and Sandringham Hospital.

The initial baseline information was collected through a questionnaire survey between September 2009 and December 2010 (Appendix A). All nurses working in the three hospitals at the time of the study were invited to participate in the study (N = 3086). The nurses were sent a mailout package which contained a personally addressed invitation letter, an
Chapter 2

information booklet describing the study, the questionnaire with the consent form and a ‘reply paid’ envelope. The nurses had the choice of completing the questionnaire on-line or to return the paper questionnaire. Two weeks after the first mail-out a reminder postcard was sent to those who had not returned the questionnaire. Two weeks later a second mail-out package including a personally addressed invitation letter was sent to those who had not returned a questionnaire or who had not indicated that they did not wish to participate. Four weeks after the second mail-out a third mail-out package including a personally addressed revised invitation letter was sent to those who had not returned a questionnaire.

Recruitment also included a series of four promotional posters placed at strategic location within the three hospitals, email from the Australian Nursing Federation (Victorian Branch) encouraging participation to all its members in AlfredHealth, and announcement and promotion through dedicated a website (http://coeh.monash.org/cupid.html) and through AlfredHealth newsletters. The recruitment process is shown in Figure ii.

Figure ii: Recruitment process for baseline study.
Chapter 2

Due to privacy reasons, the research team could not be provided with any prior personal information about the nurses and was unable to contact the non-responders directly. The ethical approval received from The Alfred Ethics Committee did not allow us to have access to the contact information of the nurses from AlfredHealth. It also did not allow us to inform AlfredHealth administration of those nurses that have and have not responded to the questionnaire, and mail packages that were ‘return-to-sender’. For these reasons we were unable to verify the addresses of the mail packages that were ‘return-to-sender’. Mail packages that were ‘returned-to-sender’ were considered non-contactable and were not included in the study (n=208).

All of the 1,119 nurses who participated in the baseline study were invited to take part in the follow-up study (Appendix B). The follow-up study was conducted between October 2010 and January 2011. The recruitment process was similar to the baseline study except for the promotional posters. It included personalised email and telephone reminder to the participants who had not returned the questionnaire. Data collection was also similar to the baseline study, although there was no option for on-line completion of the questionnaire. This was because only a very small number of participants (n<50) opted for this method during the baseline study. Further details about the methods specific to each of chapters 2-4 are included in either the introduction to those chapters and/or the paper which forms the main part of each of those chapters.

This chapter aims to investigate an emerging issue related to the risk factors for neck and shoulder pain. In earlier studies, researchers have found that the risk factors for MSDs of the back were different from those of the neck and shoulder (Ahlberg-Hulten et al., 1995, Bru et al., 1996). It is hypothesised that the situation would be similar for the neck and shoulder, i.e. that the risk factors for having neck or shoulder pain alone and both neck and shoulder pain
Chapter 2

may be different. Previous studies on neck and shoulder pain investigated MSDs of the neck and shoulder separately (Ahlberg-Hulten et al., 1995, Bru et al., 1996, Bernard et al., 1994, Burdorf et al., 1997, Lagerström et al., 1995, Lemasters et al., 1998, Johansson, 1995) or MSDs of the neck-shoulder as a single unit (Bergqvist et al., 1995, Dimberg et al., 1989, Warming et al., 2009). Most of these studies did not investigate risk factors for neck pain alone and shoulder pain alone as they did not exclude those with neck pain when investigating those with shoulder pain and vice versa.

This chapter aimed to test this hypothesis by investigating the risk factors for neck pain alone, shoulder pain alone, and neck and shoulder pain among hospital based nurses. Participants were categorised as those who reported neck pain without shoulder pain, shoulder pain without neck pain, and neck and shoulder pain for at least one day in the past month, and were compared with those having no neck and shoulder pain. The risk factors considered included individual risk factors such as mental health, physical health, health beliefs and somatisation tendency and workplace risk factors such as physical and psychosocial factors.

The association between the risk factors and outcome was estimated using multinominal logistic regression adjusting for age, gender and pain in other sites (presence or absence of low back, elbow, wrist or hand and knee pain). The final model consisted of all factors that were significantly associated with at least one of the outcome categories in the multivariate regression together with age, gender and pain in other sites. The findings from this chapter have increased our understanding of MSDs of the neck and shoulder regions, and identification of risk factors specific to the neck pain alone, shoulder pain alone, and neck and shoulder pain may help us to prevent these different conditions and improve the management of pain in these regions.
Chapter 2

This chapter has been published in Occupational & Environmental Medicine (Occup Environ Med 2012;69, 198-204; Published Online First: 18 October 2011).
2.2 Declaration for Thesis Chapter

Hoe VCW, Kelsall HL, Urquhart DM, Sim MR. Risk factors for musculoskeletal symptoms of the neck or shoulder alone or neck and shoulder among hospital nurses. Occup Environ Med 2011;oemed-2011-100302 Published Online First: 18 October 2011.

Declaration by candidate

In the case of Chapter 2 the nature and extent of my contribution to the work was the following:

<table>
<thead>
<tr>
<th>Nature of contribution</th>
<th>Extent of contribution (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal author: Responsible for overall concept and design; development of the study design, methods and questionnaire; data collection; data cleaning; literature review; analysis; development and drafting of the submitted manuscript, and critical revision of the manuscript. Responsible author who accepts overall responsibility for the publication.</td>
<td>80%</td>
</tr>
</tbody>
</table>

The following co-authors contributed to the work. Co-authors who are students at Monash University must also indicate the extent of their contribution in percentage terms:

<table>
<thead>
<tr>
<th>Name</th>
<th>Nature of contribution</th>
<th>Extent of contribution (%) for student co-authors only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helen L Kelsall</td>
<td>Contributed to the drafting and critical revision of the manuscript; development of the study design, methods and questionnaire</td>
<td>N/A</td>
</tr>
<tr>
<td>Donna M Urquhart</td>
<td>Contributed to the drafting and critical revision of the manuscript; development of the questionnaire</td>
<td>N/A</td>
</tr>
<tr>
<td>Malcolm R Sim</td>
<td>Contributed to the drafting and critical revision of the manuscript; development of the study design, methods and questionnaire</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Candidate’s Signature: [Signature]

Date: 02/11/2011

Declaration by co-authors

The undersigned hereby certify that:

(1) the above declaration correctly reflects the nature and extent of the candidate’s contribution to this work, and the nature of the contribution of each of the co-authors.

(2) they meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;

(3) they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;

(4) there are no other authors of the publication according to these criteria;

(5) potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and

(6) the original data are stored at the following location(s) and will be held for at least five years from the date indicated below:

Location(s): Monash University Department of Epidemiology and Preventive Medicine, Alfred Centre

Signature 1: [Signature]

Date: 2/11/2011

Signature 2: [Signature]

Date: 2/11/2011

Signature 3: [Signature]

Date: 2/11/2011
Risk factors for musculoskeletal symptoms of the neck or shoulder alone or neck and shoulder among hospital nurses

Victor C W Hoe,1,2 Helen L Kelsall,1 Donna M Urquhart,1 Malcolm R Sim1

ABSTRACT

Objectives To investigate the relationship between sociodemographic, individual and work place factors, and neck pain alone, shoulder pain alone, and neck and shoulder pain among nurses working across three public hospitals in Melbourne, Australia.

Methods Information on participant demographics, somatisation tendency, health beliefs, mental and physical health status, workplace physical and psychosocial factors, and musculoskeletal symptoms and pain at several body sites was collected.

Results 1111 participants (response rate 38.6%) were included in the study: 17.2% reported neck pain alone, 11.6% shoulder pain alone and 15.8% both neck and shoulder pain in the past month. Self-reported neck and shoulder pain were independently associated with poorer mental (OR 0.96, 95% CI 0.94 to 0.98) and physical (0.92, 0.90 to 0.95) health and well-being, somatisation (1.77, 1.03 to 3.04) and negative work-causation beliefs (2.51, 1.57 to 3.99). Neck pain alone was more consistently associated with sociodemographic factors, mental (0.97, 0.96 to 0.99) and physical (0.97, 0.94 to 0.99) health and well-being, and shoulder pain alone was associated with physical health and well-being (0.95, 0.92 to 0.98) and fear-avoidance beliefs (0.45, 0.24 to 0.86).

Conclusion Risk factors for self-reported pain between regions of the neck and shoulder alone, and neck and shoulder differed. While neck and shoulder pain was consistently associated with several risk factors, neck and shoulder pain in isolation were both associated with physical health and well-being and individually associated with sociodemographic and health beliefs, respectively. These findings suggest that different factors may be associated with a single pain region versus pain in two regions.

What this paper adds

- The risk factors for neck pain alone or shoulder pain alone, and neck and shoulder pain were different.
- Employment and work-related psychosocial factors were not associated with neck pain alone or shoulder pain alone, or neck and shoulder pain.
- Work-related physical factors, mental and physical health and well-being, health beliefs and somatisation tendency were consistently associated with neck and shoulder pain.
- Whereas neck pain alone was more consistently associated with sociodemographic factors and physical health and well-being, shoulder pain alone was associated with fear-avoidance beliefs and physical health and well-being.
- Strategies to control work-related musculoskeletal disorders of the neck and shoulder should take account of the difference in risk factors for neck or shoulder pain alone, and neck and shoulder pain.

INTRODUCTION

Work-related musculoskeletal disorders (MSD) of the neck and shoulders are common among nursing personnel, and are the second most common MSD after low back pain.1 2 They make a major contribution to the cost of work-related illness in developed countries (USA, Europe and Australia)3—5 and those with MSD are more likely to leave the nursing workforce.5

The risk factors associated with MSD of the neck and shoulder include individual and workplace factors. Workplace risk factors include physical workload, and organisational and psychosocial factors.7—9 However, several reviews have found that the effects of these factors were not consistent and the associations were generally not strong.5—11 whereas individual factors such as female gender, mental distress and low physical capacity were more strongly associated.8 9 These identified risk factors, however, do not fully explain the development of MSD of the neck and shoulder. There is preliminary evidence to suggest that somatisation tendency could be a risk factor for MSD.12

Risk factors for MSD differ between body sites. Early studies of healthcare workers found the risk factors for MSD of the back to be different from those for the neck and shoulder region.14 15 Previous studies of the neck and shoulder region have investigated MSD of the shoulder and neck separately.12—18 or the neck and shoulder as a single unit.19 20 Most of these studies did not investigate the risk factors for neck pain alone and shoulder pain alone as they did not exclude those with neck pain when investigating shoulder pain and vice versa. Identifying the risk factors specific to neck pain alone, shoulder pain alone and neck and shoulder pain may help us prevent these different conditions and improve the management of
muscular pain in these regions, especially when there is more than one site of pain.

The aim of this study was to investigate the relationship between individual risk factors such as mental health, physical health, health beliefs and somatisation tendency, and workplace risk factors such as physical and psychosocial factors, and reporting of neck pain alone, shoulder pain alone, and neck and shoulder pain among hospital-based nurses.

METHODS
This study is the Australian arm of the International Study of Physical, Cultural and Psychosocial Influences on Musculoskeletal Symptoms and Associated Disability (CUPID Study). This is a baseline survey of a cohort which is to be followed over time.

Study population
The study population consisted of all nurses working for a major healthcare group across three public hospitals in Melbourne, Australia. The hospitals were a tertiary referral and teaching hospital, a hospital providing mainly rehabilitation and aged care services, and a community-based hospital.

Recruitment process
All nurses working in the three hospitals at the time of the study were invited to participate in the study (N=3086) and were sent a mailout package which contained a personally addressed invitation letter, an information booklet describing the study, the questionnaire with the consent form and a ‘reply paid’ envelope. Two weeks after the first mailout a postcard reminder was sent to all the nurses who had not responded. This was followed by a second mail package 2 weeks later and a final mail package 4 weeks after that. The nurses had the choice of completing the questionnaire online using a study identification and log-in code which they could personalise. Participants were eligible to enter a draw for a chance to win one of 10 vouchers each worth AUD100 from a major department store. For privacy reasons, the research team had no prior personal information about the nurses and was unable to contact the non-responders directly. Mail packages that were returned-to-sender were considered non-contactable and were not included in the study (N=208).

Assessment of outcome measures
The instrument used in this study included the core international CUPID Study questionnaire, additional questions about ethnicity and several validated instruments. The questionnaire asked about sociodemographic characteristics, occupational variables, work-related physical and psychosocial risk factors, mental and physical health, and somatisation tendency and health beliefs. The questions on musculoskeletal symptoms were adapted from the Nordic Questionnaire on musculoskeletal complaints, and were accompanied by anatomical diagrams depicting the specified sites. The participants were asked whether they had experienced pain in the neck or shoulder lasting for more than 1 day during the previous month.

Assessment of work-related physical and psychosocial factors
Physical demands were measured using a dichotomous scale (No/Yes) for five strenuous tasks undertaken during an average working day. Measures of psychosocial risk factors were based on the job control and demand model. The job control measure asked three questions on the participant’s choice in deciding how to do the work, what to do at work, and their work timetable and breaks, with response options of ‘often’, ‘sometimes’, ‘seldom’ and ‘never/almost never’. Job control was classified as ‘low’ when two or more responses were ‘never/almost never’. High job strain was defined as having low job control and working under time pressure. Questions were also asked about job satisfaction and security and support from their co-worker/supervisor.

Assessment of mental and physical health, and anthropometric characteristics
Mental health was assessed using the Mental Health Inventory-5 (MHI-5) and the Mental Component Summary Scale (SF-12 MCS) of the 12-item version of the Short Form Health Survey (SF-12v2). The MHI-5 contains five items with a six-point scale (ie, from ‘all of the time’ to ‘none of the time’) assessing how participants feel and have been during the past month.

The score was transformed into a variable ranging between 1 and 100, where a high score indicates better mental health, and a score of <.76 (sensitivity 0.76, specificity 0.77) indicates the presence of the common mental disorders of anxiety and depression. Physical health and well-being was assessed using the Physical Component Summary Scale (SF-12 PCS) of the SF-12v2. The SF-12 PCS and SF-12 MCS scores were calculated using standard scoring algorithms, in which no missing data were allowed. The score ranges from 0 to 100, where the higher score indicates better physical and mental health.

Above average height was defined as a reported height of >165.0 cm (female)/178.0 cm (male) according to the Australian average height. Normal weight was defined as a body mass index (BMI) of <25.0 kg/m², overweight as BMI 25.0–29.9 kg/m² and obesity as BMI ≥30.0 kg/m².

Health beliefs and somatisation
Health beliefs were assessed using questions from the Fear-Avoidance Beliefs Questionnaire and a question on the work-relatedness of upper-limb pain. Participants were considered to hold fear-avoidance beliefs if they completely agreed that physical activity should be avoided as it might harm the arm and rest was needed for it to get better. Participants who completely agreed that pain in the arm, shoulder or hands is commonly caused by people’s work were considered to hold the belief that work is the cause of pain in the upper limb.

Somatisation was measured using the somatisation subscale of the Brief Symptoms Inventory, and was classified according to the number of somatic symptoms (ie, nausea, faintness, dizziness, weakness, numbness in the body, chest pain and breathing difficulties) that were rated as at least moderately distressing. Those who reported two or more of seven symptoms in the past 7 days were defined as having somatisation tendency.

Statistical analysis
The outcome measures were participants’ reporting of (i) neck pain alone (with no shoulder pain), (ii) shoulder pain alone (with no neck pain) and (iii) neck and shoulder pain, for at least 1 day in the past month. The outcomes were mutually exclusive and were compared with those of nurses who did not report neck and shoulder pain in the past month. The means and standard deviations of normally distributed continuous variables and the median and inter-quartiles ranges of skewed variables are presented. The associations between the demographic, individual, occupational and work-related physical and psychosocial risk factors, and the odds (OR with 95% CI) of neck pain in those with no shoulder pain (neck pain alone), shoulder pain in...
those with no neck pain (shoulder pain alone), and neck and shoulder pain, compared to those with no neck and shoulder pain in the past month were estimated using multinomial logistic regression adjusting for age (as a continuous variable with a unit of analysis of 1 year), gender and pain in other sites (presence or absence of low back pain, elbow pain, hand/wrist pain and knee pain). The Wald test was used to evaluate whether the differences in the OR in those with neck pain alone, shoulder pain alone, or neck and shoulder pain in the past month were statistically significant.

Factors that were significantly associated (p<0.05) with at least one of the outcome categories in the multivariate regression models were introduced simultaneously in a single model together with age, gender and pain in other sites. The analysis was conducted using STATA/SE 10 (StataCorp LP, College Station, Texas, USA) statistical software.

## RESULTS
A total of 1119 nurses completed the questionnaires, of whom 1111 (response rate 38.6%) were included in the study; eight were excluded as they worked less than 4 h per week. Demographic differences between the participants and the total hospital nursing population were small; the participants had a slightly higher proportion of females (91% vs 87%), were slightly older (mean age 41.5 vs 39.3 years, same range 21–74 years) and had a greater proportion of full-time (38.2% vs 31.8%) and part-time (50.1% vs 48.6%) workers.

The characteristics of the participants are presented in table 1. Although the majority of nurses were born in Australia, 51 other countries, mostly Asian or European, were also represented. Over half (55.4%) of the participants reported no neck and shoulder pain, 17.2% reported neck pain alone, 11.6% reported shoulder pain alone and 15.8% reported both neck and shoulder pain.

### Table 1 Characteristics of participants who reported no neck and shoulder pain, neck pain alone, shoulder pain alone, or neck and shoulder pain in the past month

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>No neck and shoulder pain (n = 616)</th>
<th>Neck pain alone (n = 191)</th>
<th>Shoulder pain alone (n = 129)</th>
<th>Neck and shoulder pain (n = 175)</th>
<th>p Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years), mean (SD)</td>
<td>40.9 (11.5)</td>
<td>41.1 (11.8)</td>
<td>42.1 (11.6)</td>
<td>43.7 (10.4)</td>
<td>0.035</td>
</tr>
<tr>
<td>Gender</td>
<td>Male</td>
<td>67 (10.9)</td>
<td>10 (5.3)</td>
<td>17 (13.2)</td>
<td>5 (2.9)</td>
</tr>
<tr>
<td>Female</td>
<td>549 (89.1)</td>
<td>180 (94.7)</td>
<td>112 (86.8)</td>
<td>170 (97.1)</td>
<td></td>
</tr>
<tr>
<td>Marital status</td>
<td>Married/de facto (co-habiting)</td>
<td>339 (63.7)</td>
<td>110 (57.6)</td>
<td>81 (63.3)</td>
<td>103 (59.5)</td>
</tr>
<tr>
<td>Single</td>
<td>163 (26.7)</td>
<td>51 (26.7)</td>
<td>35 (27.3)</td>
<td>50 (28.9)</td>
<td>0.056</td>
</tr>
<tr>
<td>Divorced/widowed</td>
<td>59 (9.6)</td>
<td>30 (15.7)</td>
<td>12 (9.4)</td>
<td>20 (11.6)</td>
<td></td>
</tr>
<tr>
<td>Country of origin</td>
<td>Australia</td>
<td>405 (65.9)</td>
<td>142 (75.1)</td>
<td>83 (64.3)</td>
<td>117 (67.2)</td>
</tr>
<tr>
<td>Countries in Asia</td>
<td>80 (13.0)</td>
<td>14 (7.4)</td>
<td>17 (13.2)</td>
<td>30 (17.3)</td>
<td></td>
</tr>
<tr>
<td>Other countries</td>
<td>130 (21.1)</td>
<td>33 (17.5)</td>
<td>29 (22.5)</td>
<td>27 (15.5)</td>
<td></td>
</tr>
<tr>
<td>Qualification</td>
<td>Up to undergraduate</td>
<td>341 (55.8)</td>
<td>86 (45.7)</td>
<td>75 (58.1)</td>
<td>93 (53.4)</td>
</tr>
<tr>
<td>Post-graduate up to PhD</td>
<td>270 (44.2)</td>
<td>102 (54.3)</td>
<td>54 (41.9)</td>
<td>81 (46.6)</td>
<td></td>
</tr>
<tr>
<td>Body mass index, kg/m²</td>
<td>Normal weight, &lt;25.0</td>
<td>341 (57.9)</td>
<td>120 (65.6)</td>
<td>59 (47.6)</td>
<td>64 (40.5)</td>
</tr>
<tr>
<td>Overweight, 25.0–29.9</td>
<td>172 (29.2)</td>
<td>50 (27.3)</td>
<td>53 (43.6)</td>
<td>72 (45.6)</td>
<td></td>
</tr>
<tr>
<td>Obese, ≥30.0</td>
<td>76 (12.9)</td>
<td>13 (7.1)</td>
<td>11 (8.8)</td>
<td>22 (13.9)</td>
<td></td>
</tr>
<tr>
<td>Height</td>
<td>Up to average height</td>
<td>333 (56.0)</td>
<td>86 (46.7)</td>
<td>67 (54.0)</td>
<td>105 (63.6)</td>
</tr>
<tr>
<td>Above average height</td>
<td>262 (44.0)</td>
<td>98 (53.3)</td>
<td>57 (46.0)</td>
<td>60 (36.4)</td>
<td></td>
</tr>
<tr>
<td>Smoking status</td>
<td>Never smoked</td>
<td>389 (63.2)</td>
<td>106 (55.5)</td>
<td>73 (56.6)</td>
<td>109 (62.3)</td>
</tr>
<tr>
<td>Ex-smoker</td>
<td>183 (29.7)</td>
<td>66 (34.6)</td>
<td>50 (38.8)</td>
<td>43 (24.6)</td>
<td></td>
</tr>
<tr>
<td>Current smoker</td>
<td>44 (7.1)</td>
<td>19 (9.9)</td>
<td>6 (4.6)</td>
<td>23 (13.1)</td>
<td></td>
</tr>
<tr>
<td>Alcohol consumption (on one occasion)</td>
<td>&lt;2 standard alcoholic drinks</td>
<td>285 (46.3)</td>
<td>86 (45.0)</td>
<td>53 (41.1)</td>
<td>87 (49.7)</td>
</tr>
<tr>
<td>≥2 standard alcoholic drinks</td>
<td>331 (53.7)</td>
<td>105 (55.0)</td>
<td>76 (58.9)</td>
<td>88 (50.3)</td>
<td></td>
</tr>
<tr>
<td>Employment status</td>
<td>Full-time</td>
<td>237 (38.8)</td>
<td>69 (36.5)</td>
<td>50 (38.8)</td>
<td>65 (37.6)</td>
</tr>
<tr>
<td>Part-time/casual</td>
<td>374 (61.2)</td>
<td>120 (63.5)</td>
<td>79 (61.2)</td>
<td>108 (62.4)</td>
<td></td>
</tr>
<tr>
<td>Years in current job</td>
<td>&lt;5 years</td>
<td>305 (50.1)</td>
<td>95 (50.3)</td>
<td>59 (45.7)</td>
<td>69 (39.7)</td>
</tr>
<tr>
<td>≥5 years</td>
<td>304 (49.9)</td>
<td>94 (49.7)</td>
<td>70 (54.3)</td>
<td>105 (60.3)</td>
<td></td>
</tr>
<tr>
<td>Work hours per week</td>
<td>&lt;40 h</td>
<td>544 (89.8)</td>
<td>162 (85.7)</td>
<td>115 (91.3)</td>
<td>153 (87.9)</td>
</tr>
<tr>
<td>≥40 h</td>
<td>62 (10.2)</td>
<td>27 (14.3)</td>
<td>11 (8.7)</td>
<td>21 (12.1)</td>
<td></td>
</tr>
<tr>
<td>Pain in other sites</td>
<td>No</td>
<td>372 (60.4)</td>
<td>88 (46.1)</td>
<td>59 (45.7)</td>
<td>33 (18.9)</td>
</tr>
<tr>
<td>Yes</td>
<td>244 (39.6)</td>
<td>103 (53.9)</td>
<td>70 (54.3)</td>
<td>142 (81.1)</td>
<td></td>
</tr>
</tbody>
</table>

*p Values were derived from either one-way ANOVA for quantitative data or the χ² test for categorical data.†Height was classified as above average (≥165.0 cm (female)/178.0 cm (male)) according to the Australian average height.‡Pain in other sites includes low back pain, elbow pain, wrist/hand pain and/or knee pain.

The characteristics of the participants are presented in table 1. Although the majority of nurses were born in Australia, 51 other countries, mostly Asian or European, were also represented. Over half (55.4%) of the participants reported no neck and shoulder pain, 17.2% reported neck pain alone, 11.6% reported shoulder pain alone and 15.8% reported both neck and shoulder pain.
pain in the past month. More than 80% of those with neck and shoulder pain also had pain in other sites (low back, elbow, hand/wrist or knee), whereas only 55% with neck alone and 54% with shoulder pain alone had pain in other sites.

Table 2 shows that female gender was associated with neck pain alone and neck and shoulder pain but not with shoulder pain alone, and age was associated with neck pain alone and neck and shoulder pain. Divorced or widowed marital status, having at least 1 h/day worked per week were not associated with BMI and pain was similar in the simple and final models. Pain in all sites was no longer associated with workplace and high job strain were all associated with neck and shoulder pain. High job strain and low job support were associated with neck pain alone, while none of these factors were associated with neck pain alone.

Table 3 shows that employment status, years in current job and number of hours worked per week were not associated with any site of pain. The use of a keyboard/typewriter for >4 h/day and flexion/extension of the elbow for >1 h/day were associated with neck and shoulder pain but not with either site of pain alone. Low job security, low co-worker/supervisor support in the workplace and high job strain were all associated with neck and shoulder pain. High job strain and low job support were also associated with shoulder pain alone, while none of these factors were associated with neck pain alone.

Table 4 shows that poorer mental health caseness as defined by an MHI-5 score of <76 was associated with neck and shoulder pain but not with either site of pain alone. Somatisation tendency and work causation beliefs were associated with neck and shoulder pain but not with either site of pain alone. The odds of neck pain alone and neck and shoulder pain were found to decrease with each unit increase in the SF-12 MCS score (better mental health and well-being). The odds of shoulder pain alone and neck and shoulder pain decreased with each unit increase in the SF-12 PCS score (better physical health and well-being) compared to those with no neck and shoulder pain.

In the final multivariate model (table 5), country of birth in Asia remained associated with decreased odds of reporting neck pain alone as compared to Australian born nurses. Poorer general physical health and well-being was associated with pain in all three outcome categories. The situation was similar for the SF-12 MCS where those reporting neck pain alone and neck and shoulder pain were more likely to have lower scores (representing poorer mental health and well-being). The association between BMI and pain was similar in the simple and final multivariate models. Pain in all sites was no longer associated with workplace psychosocial or physical load factors, and only flexion/extension of the elbow for >1 h/day remained associated with neck and shoulder pain in the final model. Fear-avoidance beliefs continued to be associated with shoulder pain alone and somatisation tendency and work-causation beliefs with neck and shoulder pain.
DISCUSSION

Our study findings show that somatisation tendency, health beliefs, and mental and physical health and well-being were associated with reported pain in the neck and shoulder. Factors associated with neck and shoulder pain alone differed: neck pain alone was more consistently associated with demographic factors and BMI, whereas shoulder pain alone was associated with health beliefs. General physical health and well-being was associated with both neck and shoulder pain alone.

Somatisation tendency was an important factor associated with the reporting of recent musculoskeletal pain in the neck and shoulder region. Somatisation tendency is linked to heightened awareness of somatic symptoms and a tendency to attribute such symptoms to physical illness. In this study, somatisation was strongly associated with neck and shoulder pain, with the association persisting in the full model. This is consistent with earlier studies which found that somatisation tendency was associated with chronic widespread pain.13 29 31

In an earlier study, Solidaki et al.29 found that health beliefs such as fear-avoidance beliefs and work-causation beliefs were risk factors for widespread musculoskeletal pain among nurses, postal clerks and office workers. In our study we found work-causation beliefs to be strongly positively associated with nurses reporting neck and shoulder pain but not with either site of pain alone. Fear-avoidance beliefs were negatively associated with shoulder pain alone, and also negatively associated with neck and shoulder pain, although not statistically significantly. The difference in the findings may be attributable to the populations: our population consists of only nurses who may have different health beliefs as a result of their professional training and work experience.

Physical load factors were not prominent as risk factors in our study, with associations only found for neck and shoulder pain. Our finding also that physical load factors were not associated with neck pain alone and shoulder pain alone is consistent with an earlier study by Smith et al.2 which found that physical load factors were not associated with neck pain and shoulder pain. The physical load factors may affect the neck and shoulder together and not the individual sites in isolation. Our finding that BMI in the obese range was inversely associated with neck pain alone is not consistent with previous research into healthcare workers.12 0 This finding is difficult to explain, but may be influenced by the cross-sectional design and reflect selection pressures, rather than being a true protective factor.

We found that there was no association between workplace psychosocial factors and pain in any sites in the full model. Several systematic reviews have found that workplace psychosocial factors, for example, high job strain and low support, were associated with neck and shoulder pain, although whether these were considered as separate sites was not always clear.8 9 11 However, a lack of association, consistent with our findings, was also observed in two studies conducted on healthcare workers.1 20 Psychosocial factors assessed using the job control demand model may have less impact in the healthcare professions.
Our study had several strengths. The questionnaire in this study on musculoskeletal disease, and physical and psychosocial factors has been used in earlier studies\(^2\) and included validated instruments to measure other risk factors, for example, the Brief Symptoms Inventory,\(^3\) the SF-12v2\(^2\) and the MHI-5.\(^2\) The study population comprised all nurses working across three hospitals and performing a range of duties. We used a comprehensive promotional and recruitment strategy to maximise response including promotional posters, three mail-outs, reminder postcards, support emails from the Australian Nursing Federation (Victoria branch) and incentives, and achieved a response rate of 59%.

Our study had some limitations that should be acknowledged. While the response rate of our study was lower than the reported response rate of 58% (nurses, postal and office workers combined) for the New Zealand arm of the CUPID Study,\(^2\)\(^2\)\(^2\) comparison of our study group with the overall nursing study population on the summary demographic and employment status data that were available to us suggests that they were similar and that respondent bias may be limited. The response rate in our study was comparable to that in recent studies conducted in nurses from several European countries.\(^3\) Our paper focused on comparing associations between those without neck and shoulder pain and the three other groups and these comparisons are less likely to be influenced by respondent bias, and the analysis related to reported pain in the month before the survey. Recall bias may have occurred whereby participants with MSD may be more likely to report exposure to risk factors. Definition as having neck and shoulder pain in our study did not necessary imply that pain occurred simultaneously, only that neck and shoulder pain had both been reported in the past month. In addition, due to the cross-sectional design of the study, the direction of the association for the various factors cannot be established.

Our study found several important differences in risk factors for nurses with neck and shoulder pain compared with pain in either site alone. The only factor that was associated with pain in all the three outcome categories was physical health and well-being, with a similar pattern for mental health and well-being but for an upper CI of unity for the association with shoulder

### Table 4 Association between mental and physical health and health beliefs factors and reporting of neck pain alone, shoulder pain alone, and neck and shoulder pain compared with no neck and shoulder pain in the past month

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Neck pain alone OR (95% CI)</th>
<th>Shoulder pain alone OR (95% CI)</th>
<th>Neck and shoulder pain OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF-12 MCS</td>
<td>0.98* (0.96 to 0.99)</td>
<td>0.99* (0.97 to 1.01)</td>
<td>0.97* (0.96 to 0.99)</td>
</tr>
<tr>
<td>SF-12 PCS</td>
<td>0.99* (0.97 to 1.01)</td>
<td>0.96* (0.93 to 0.98)</td>
<td>0.93* (0.91 to 0.95)</td>
</tr>
<tr>
<td>MHI-5 caseness, score &lt;76 †</td>
<td>1.23* (0.87 to 1.72)</td>
<td>1.45* (0.98 to 2.15)</td>
<td>1.89* (1.32 to 2.71)</td>
</tr>
<tr>
<td>Somatisation tendency ‡</td>
<td>1.63* (1.00 to 2.65)</td>
<td>1.42* (0.79 to 2.57)</td>
<td>2.98* (1.89 to 4.68)</td>
</tr>
<tr>
<td>Fear-avoidance beliefs §</td>
<td>0.84 (0.55 to 1.29)</td>
<td>0.48 (0.27 to 0.87)</td>
<td>0.90 (0.56 to 1.43)</td>
</tr>
<tr>
<td>Work-causation beliefs ‡</td>
<td>1.23* (0.88 to 1.74)</td>
<td>1.36* (0.91 to 2.03)</td>
<td>2.62* (1.74 to 3.94)</td>
</tr>
</tbody>
</table>

All OR are adjusted for age as a continuous variable, gender and pain in the low back, elbow, hand/wrist or knee.

* Wald test, \(p<0.05\), indicates that the OR is statistically different between the three groups.

† Somatisation tendency defined as \( \leq 2 \) symptoms out of 7 that were rated as at least moderately distressing.

‡ Poor mental health (score <76) assessed using the MHI-5 scale.

§ Completely agreed or tended to agree that one should avoid physical activity when in pain, and that rest was needed for recovery.

\* Completely agreed or tend to agree that these problems are commonly caused by people’s work.

### Table 5 Multivariate model for association between those reporting neck pain alone, shoulder pain alone and neck and shoulder pain compared those with no neck and shoulder pain in the past month

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Neck pain alone OR (95% CI)</th>
<th>Shoulder pain alone OR (95% CI)</th>
<th>Neck and shoulder pain OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female gender</td>
<td>2.45* (1.13 to 5.30)</td>
<td>0.80* (0.43 to 1.48)</td>
<td>3.20* (1.20 to 8.61)</td>
</tr>
<tr>
<td>Country of birth</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australia</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Countries in Asia</td>
<td>0.37 (0.19 to 0.74)</td>
<td>0.95 (0.48 to 1.86)</td>
<td>1.10 (0.60 to 2.03)</td>
</tr>
<tr>
<td>Other countries</td>
<td>0.78 (0.49 to 1.23)</td>
<td>1.27 (0.77 to 2.09)</td>
<td>0.83 (0.48 to 1.45)</td>
</tr>
<tr>
<td>Body mass index, kg/m²</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;25.0</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>25.0–29.9</td>
<td>0.70* (0.47 to 1.06)</td>
<td>1.47* (0.94 to 2.31)</td>
<td>1.92* (1.22 to 3.01)</td>
</tr>
<tr>
<td>≥30.0</td>
<td>0.35* (0.18 to 0.68)</td>
<td>0.60* (0.29 to 1.25)</td>
<td>0.88* (0.46 to 1.68)</td>
</tr>
<tr>
<td>Flexion/extension of elbow &gt;1 h</td>
<td>1.09 (0.76 to 1.56)</td>
<td>1.10 (0.72 to 1.67)</td>
<td>1.63 (1.07 to 2.49)</td>
</tr>
<tr>
<td>SF-12 MCS</td>
<td>0.97* (0.96 to 0.99)</td>
<td>0.98* (0.96 to 1.00)</td>
<td>0.96* (0.94 to 0.98)</td>
</tr>
<tr>
<td>SF-12 PCS</td>
<td>0.97* (0.94 to 0.99)</td>
<td>0.95* (0.92 to 0.98)</td>
<td>0.92* (0.90 to 0.95)</td>
</tr>
<tr>
<td>Somatisation †</td>
<td>1.51 (0.87 to 2.62)</td>
<td>1.31 (0.69 to 2.50)</td>
<td>1.77 (1.03 to 3.04)</td>
</tr>
<tr>
<td>Fear-avoidance beliefs ‡</td>
<td>0.96 (0.61 to 1.51)</td>
<td>0.45 (0.24 to 0.86)</td>
<td>0.66 (0.38 to 1.16)</td>
</tr>
<tr>
<td>Work-causation beliefs ‡</td>
<td>1.19* (0.82 to 1.71)</td>
<td>1.40* (0.91 to 2.15)</td>
<td>2.51* (1.57 to 3.99)</td>
</tr>
</tbody>
</table>

All OR are mutually adjusted and adjusted for age as a continuous variable, gender and pain in the low back, elbow, hand/wrist or knee.

* Wald test, \( p<0.05 \), indicates that the OR is statistically different between the three groups.

† Somatisation tendency defined as \( \leq 2 \) symptoms out of 7 that were rated as at least moderately distressing.

‡ Completely agreed or tended to agree that one should avoid physical activity when in pain, and that rest was needed for recovery.

§ Completely agreed or tend to agree that these problems are commonly caused by people’s work.

SF-12 MCS, Mental Component Summary Scale of the 12-item version of the Short Form Health Survey; SF-12 PCS, Physical Component Summary Scale of the 12-item version of the Short Form Health Survey.
pain. Somatisation tendency and work-causation beliefs had the strongest association with neck and shoulder pain; mental and physical health and well-being, workplace physical load factors and other demographic factors were also associated. These factors were less consistently associated with neck pain alone or shoulder pain alone. In the management of neck and shoulder pain in the workplace, consideration should be given not only to workplace risk factors but also to mental health, physical health, health beliefs and somatisation tendency.

Acknowledgements We acknowledge assistance from the CUPID international study team, led by Professors David Coggon and Keith Palmer, and a group based at the Medical Research Council Epidemiology Resource Centre, University of Southampton.

Funding Funding was received from the Monash University Strategic Grant Scheme and a Monash University Near Miss Grant for NHMRC projects in 2008. VH was supported by a NHMRC Public Health Capacity Building Grant 546248, Australia and a Monash Senior Postdoctoral Fellowship.

Competing interests None.

Ethical approval The study was approved by the Monash University Human Research Ethics Committee and The Alfred Ethics Committee.

Provenance and peer review Not commissioned; internally peer reviewed.

REFERENCES


Workplace
3. Investigating the prevalence and factors associated with wrist or hand pain among Australian nurses.

3.1 Introduction

In Chapter 2, the main finding was that the risk factors for neck pain alone or shoulder pain alone and neck and shoulder pain together were different. Somatisation tendency, work-causation beliefs and flexion/extension of the elbow for more than 1-hour in a day were found to be associated with neck and shoulder pain together but not individual sites alone. There was no association between employment characteristics or workplace psychosocial factors and pain in any sites in the final model. The only consistent finding was an association of reduced physical health and wellbeing as measured by the SF-12 physical component scale with neck pain alone, shoulder pain alone, and neck and shoulder pain together.

In Chapter 3 the risk factors associated with wrist or hand pain will be investigated. Although wrist or hand pain may be less common than either neck or shoulder pain, pain of the wrist or hand can have a significant impact, as hand function plays an essential role in both activities of daily living and work function (Andréu et al., 2011). Wrist or hand pain can be important in occupational groups such as nurses, who are involved with regular manual handling activities, as well as fine movements of the hands and fingers. Wrist or hand pain has also been found to be as disabling as pain in other sites of the body (Matsudaira et al., 2011). Although this is an important problem, the research on wrist or hand pain is limited compared to the body of research on pain in other sites of the body. The aim of this paper was to explore the relationship between physical and psychosocial factors and wrist or hand pain in nurses.
Chapter 3

This chapter includes a paper that has been published in Injury Prevention of which I am co-first author (*Injury Prevention*, Epub 17 May 2012.doi 10.1136/injuryprev-2011-040267).
3.2 Declaration for Thesis Chapter


Declaration by candidate

In the case of Chapter 3 the nature and extent of my contribution to the work was the following:

<table>
<thead>
<tr>
<th>Nature of contribution</th>
<th>Extent of contribution (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal author (joint): Responsible for development of the questionnaire; methods and data collection; data cleaning; literature review; analysis; drafting of the submitted manuscript, and critical revision of the manuscript.</td>
<td>40%</td>
</tr>
</tbody>
</table>

The following co-authors contributed to the work. Co-authors who are students at Monash University must also indicate the extent of their contribution in percentage terms:

<table>
<thead>
<tr>
<th>Name</th>
<th>Nature of contribution</th>
<th>Extent of contribution (%) for student co-authors only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inoka K. Surawera</td>
<td>Principal author (joint): Responsible for overall concept and design; literature review; analysis; development and drafting of the submitted manuscript, and critical revision of the manuscript.</td>
<td>N/A</td>
</tr>
<tr>
<td>Helen L Kelsall</td>
<td>Contributed to the drafting and critical revision of the manuscript; development of the study design, methods and questionnaire</td>
<td>N/A</td>
</tr>
<tr>
<td>Donna M Urquhart</td>
<td>Contributed to the drafting and critical revision of the manuscript; development of the questionnaire</td>
<td>N/A</td>
</tr>
<tr>
<td>Malcolm R Sim</td>
<td>Contributed to the drafting and critical revision of the manuscript; development of the study design, methods and questionnaire</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Candidate's Signature

Date 02/11/2011

Declaration by co-authors

The undersigned hereby certify that:

1) the above declaration correctly reflects the nature and extent of the candidate's contribution to this work, and the nature of the contribution of each of the co-authors.

2) they meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;

3) they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;

4) there are no other authors of the publication according to these criteria;

5) potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and

6) the original data are stored at the following location(s) and will be held for at least five years from the date indicated below:

Location(s) Environmental and Occupational Health Unit, Ministry of Health, Sri Lanka. Monash University Department of Epidemiology and Preventive Medicine, Alfred Centre

Signature 1

Date 2/11/11

Signature 2

Date 2/11/11

Signature 3

Date 2/11/11

Signature 4

Date 2/11/11
Physical and psychosocial factors associated with wrist or hand pain among Australian hospital-based nurses

Inoka K Surawera,1,2 Victor C W Hoe,1,3 Helen L Kelsall,1 Donna M Urquhart,1 Malcolm R Sim1

ABSTRACT

Objective To assess the personal, physical and psychosocial factors associated with wrist or hand pain in Australian hospital-based nurses.

Methods Wrist or hand pain, associated disability and sickness absence, demographic, occupational, physical, psychosocial and personal factors among nurses working for three hospitals in Melbourne, Australia, were assessed in a cross-sectional study. Factors associated with wrist or hand pain in the past month were assessed using logistic regression.

Results This analysis was based on 1111 participants. The prevalence of wrist or hand pain in the past month was 15.3%. Repeated movements of the wrist or finger >4 h (OR 2.63, 95% CI 1.80 to 3.84), high job strain (1.54, 1.04 to 2.28), job insecurity (1.55, 1.04 to 2.28), somatisation tendency (2.73, 1.75 to 4.28), pain catastrophising (1.56, 1.03 to 2.37), better mental (0.97, 0.95 to 0.99) and physical (0.96, 0.94-0.98) health and well-being were associated with wrist or hand pain in the past month, after adjusting for possible confounding factors. When all significant factors were examined in the same model, repeated movements of the wrist or finger >4 h (2.50, 1.71 to 3.67), somatisation (2.61, 1.65 to 4.13) and better physical health and well-being (0.96, 0.94 to 0.99) remained independently associated with wrist or hand pain in the past month.

Conclusions This study highlights that wrist or hand pain is prevalent in hospital nurses. Workplace physical factors and personal factors were associated with wrist or hand pain. Further longitudinal investigation is needed to examine the predictive nature of these factors.

INTRODUCTION

Healthcare workers, especially nurses, are particularly at risk of developing musculoskeletal disorders (MSDs). The most common MSD among nurses is low back pain with a prevalence of 36–75%, followed by shoulder pain (20–61%), neck pain (23–52%), and arm, elbow, wrist or hand (2–24%) pain.1-7

Pain associated with MSDs of the wrist or hand can have a significant impact on the activities of workers,8 such as nurses, who are involved with regular manual handling activities, as well as fine movements of the hands and fingers. Pain experienced in the wrist or hand can be as disabling as in other sites of the body.9 However, pain associated with wrist or hand MSDs among nurses has received less attention in clinical and occupational research compared with other anatomical sites, such as the neck, back and shoulder. This gap warrants urgent attention, considering the importance of wrist and hand movements in the work of nurses.

Large variations in the prevalence of pain associated with MSDs of the wrist or hand in nurses have been reported between countries, but it has not been investigated in Australia. The 12-month prevalence of wrist or hand pain has ranged from 16% to 47% in studies conducted among nurses in Nigeria, Korea, Japan, New Zealand and Iran.5-10-14 The aetiology of MSDs of the wrist or hand has been found to be multifactorial, including physical, work, organisational, psychosocial, individual or personal and sociocultural factors among general working populations.15-18 There are limited studies among nurses looking specifically at risk factors for wrist or hand pain. We identified only two studies, conducted among Iranian nurses, which specifically looked at wrist or hand pain.13 14 These studies found that wrist or hand pain was associated with both workplace physical and psychosocial factors,13 14 but the studies did not address other personal factors such as health beliefs and somatisation tendency (a general tendency to worry about common somatic symptoms). There is some evidence that MSDs of the wrist or hand in a general working population are influenced by factors such as somatising tendency, low mood and culturally determined health beliefs.9

However, the relative importance of these factors and their role in pain associated with MSDs of the wrist or hand among nurses is not yet well understood. It is important to understand the contribution of personal, physical and psychosocial factors on pain in the wrist or hand among nurses, if preventive measures are to be optimised.

The aim of this study was to investigate the prevalence and relative contribution of personal, physical and psychosocial factors associated with wrist or hand pain among hospital based nurses in Australia.

METHODOLOGY

This cross-sectional study is the Australian arm of the International Study of Physical, Cultural and Psychosocial Influences on Musculoskeletal Symptoms and Associated Disability (CUPID Study).10,19

The study population consisted of all nurses working for three major public hospitals in Melbourne, Australia. The study was conducted between October 2009 and January 2010. All nurses working in these hospitals at the time of this survey were invited to participate in the study.
A personally addressed invitation letter, an information booklet describing the study and the study questionnaire were mailed to the study population. Nurses who did not return their questionnaire were sent a postcard reminder after 2 weeks. This was followed by a second mail package (including the questionnaire) 2 weeks later and a final mail package 4 weeks after that. The detailed recruitment process has previously been published.20

Study instrument

The instrument used in this study included the core International CUPID study questionnaire and additional instruments on pain catastrophising, resilience, and mental and physical health. The CUPID study questionnaire assessed socio-demographic characteristics, workplace physical and psychosocial factors, employment characteristics, somatisation tendency, health beliefs and musculoskeletal symptoms.

Participants’ weight and height was based on self-reported values. Normal weight was defined as a body mass index (BMI) of <25.0 kg/m², overweight as BMI 25.0–29.9 kg/m² and obesity as BMI ≥30.0 kg/m².21

The questions on musculoskeletal symptoms were adapted from the Nordic Questionnaire on musculoskeletal complaints,22 and were accompanied by anatomical diagrams depicting the specified sites. Participants were asked if they had experienced wrist or hand pain which lasted for more than a day at any time during the past 12 months, and those who had were subsequently asked if they had experienced wrist or hand pain which lasted for more than a day at any time during the past month. Workplace physical demands for wrist or hand pain were measured using a dichotomous scale for two strenuous tasks. The participants were asked ‘Does an average working day in the job involve use of a keyboard or typewriter for more than 4 hours in total?’ and ‘Does an average working day in the job involve other tasks involving repeated movements of the wrist or fingers for more than 4 hours in total?’

Workplace psychosocial factors were assessed based on the job control and demand model.23 Job control was measured using three questions each with four Likert scale options (often, rather often, sometimes, seldom and never/almost never) based on work timetables and breaks, and how and what the participants did at work. Job control was classified as ‘low’ when two or more responses were ‘never/almost never’. High job strain was defined as having low job control and working under time pressure.

Questions were also asked about job satisfaction (how satisfied have you been with your job as a whole, taking everything into consideration?), job security (how secure do you feel your job would be if you had a significant illness that kept you off work for 3 months?) and job support (when you have difficulties in your work, how often do you get help and support from your colleagues or supervisor/manager?). Each question consisted of four Likert scale options. The scores were dichotomized in the analysis, those reporting ‘dissatisfied/very dissatisfied’ were categorised as ‘low job satisfaction’, ‘rather unsafe/very unsafe’ as ‘low job security’, and ‘seldom/never’ as ‘low job support’.

Personal factors were assessed using several instruments. Somatisation tendency was assessed using the somatisation scale of the Brief Symptom Inventory.24 Somatising tendency was defined as those reporting two or more out of the seven somatic symptoms (ie, nausea, faintness, dizziness, weakness, numbness in the body, chest pain and breathing difficulties) that were rated as at least moderately distressing in the past 7 days.25

Pain catastrophising was measured with the Pain Catastrophizing Scale (PCS),26 a 13-item scale that measures the participant’s expression of worry and excessive focus on negative aspects of the painful situation, expectations of negative outcomes and the inability to cope effectively with pain.27 The options ranged from ‘not at all’ (score of 0) to ‘all the time’ (score of 4). The scores were summed and the total score ranged from 0–52. Pain catastrophising scores were categorised as high (≥75th percentile) and low (<75th percentile).

Fear-avoidance beliefs were assessed using questions from the Fear-Avoidance Beliefs Questionnaire.28 Participants were considered to hold fear-avoidance beliefs if they completely agreed that physical activity should be avoided as it might harm the arm and rest was needed for it to get better.19

Resilience refers to the dynamic process of positive adaptation in the face of stress or trauma.29 It was assessed using the 10-item Connor-Davidson Resilience Scale (CD-RISC).30 31 The instrument contains 10 items on a scale from 0 (not true at all) to 4 (true nearly all the time). The total score ranges from 0 to 40, with higher scores reflecting greater resilience. Participants with a score of ≥25th percentile were categorised as having low resilience.

Mental and physical health and well-being was measured using the Mental Component Summary Scale (SF-12 MCS) and the Physical Component Summary Scale (SF-12 PCS) of the 12-item version of the Short Form Health Survey (SF-12 v2).52 The SF-12 MCS and SF-12 PCS scores were calculated using standard scoring algorithms, in which no missing data were allowed. The scores ranged from 0 to 100, with higher scores indicating better physical and mental health and well-being.52

Limitation of the activities of daily living due to pain in the wrist or hand during the past month was assessed using five specified everyday tasks of writing, locking and unlocking doors, opening bottles, jars or taps, getting dressed and doing the jobs that are normally done around the house using a three-point Likert scale with pre-defined ranges. Pain in the wrist or hand was considered disabling according to the number of everyday activities made difficult or impossible.18 If one activity of daily living was restricted the disability was considered mild, while if two were restricted it was considered moderate and if three or more were restricted it was considered severe. Absence from work and medical consultations in the past 12 months due to wrist or hand pain were each assessed with a single question each.

Statistical analysis

The outcome measure was participants reporting wrist or hand pain for more than a day in the past month. Univariate and multivariable analyses were performed to examine the associations between the independent variables and wrist or hand pain in the past month using logistic regression models to estimate ORs and 95% CIs. In the first multivariable model, adjustment was made for the potential confounding factors of age, gender and BMI. Further analysis assessed the independent contribution of (1) employment characteristics (employment status, years in current job and working hours per week), (2) workplace physical and psychosocial factors, and (3) personal factors (mental and physical health and well-being, somatisation tendency, pain catastrophising, resilience and fear avoidance beliefs) each in a separate second multivariable model. In each of the second multivariable models, all the variables for employment characteristics, workplace factors and personal factors were included in the corresponding multivariable models along with gender, age and BMI. In the final, model all independent variables that were significant (p value <0.05) in the first multivariable model of the preceding tables, were included, together with gender, age and...
BMI. Data were analysed using Stata/IC 11 (StataCorp LP) statistical software.

RESULTS

A total of 1119 (response rate 38.9%) nurses completed the questionnaires, of whom 1111 were included in the study; eight were excluded as they worked <4 h/week. The total nursing population were obtained from the hospitals’ payroll as summary data based on the total nursing population employed at the time of the study. Demographic differences between the study participants and the total hospital nursing population were small; the participants consisted of a slightly higher proportion of females (91% vs 87%), were marginally older (mean age 41.5 vs 59.3 years, same age range 21–74 years), and had a slightly greater proportion of full-time (58.2% vs 51.8%) workers.

The prevalence of any pain in the wrist or hand in the past month was 15.3% (95% CI 13.2 to 17.4%). Of those nurses with this pain, 20.0% had pain that was not disabling, 28.2% had mild disabling pain while 18.8% and 35.0% had moderate to severe disabling pain respectively. The prevalence of any pain in the wrist or hand in the past year in the study population was 22.5% (95% CI 20.1 to 25.1%) and of these 13.6% took time off work and 42.6% sought medical advice for this pain.

Table 1 summarises the socio-demographic and anthropometric characteristics of the study participants with and without wrist or hand pain in the past month. These univariate analyses found associations of wrist or hand pain in the past month with older age, being female, being overweight (but not obese) and being separated or divorced.

Table 2 presents the associations between employment characteristics and wrist or hand pain in the past month. Although working for 5 years or more in the current job showed a significant association in the univariate analysis it was not found to be significant in the multivariable regression model after adjusting for possible confounding factors. There was also no association with years of work or employment status.

Table 3 presents the associations between workplace physical and psychosocial factors and wrist or hand pain in the past month. Associations were found for repeated movements of the wrist or finger for more than 4 hours, low job security and high job strain, after adjusting for age, gender, BMI, and other workplace physical and psychosocial factors.

Table 4 presents the associations between personal factors and wrist or hand pain in the past month. Somatisation tendency was significant associations with wrist or hand pain in the past 1 month after adjusting for age, gender, BMI and other personal factors, and better mental and physical health and well-being also gave lower odds after adjusting for the same factors. While low resilience and pain catastrophising was significantly associated with pain in the wrist or hand in the past month in the univariate analysis, this became of only borderline significance after full adjustment.

Table 5 presents the associations between significant workplace physical and psychosocial factors, and personal factors and wrist or hand pain in the past month after mutual adjustment. Significant associations were found only between repeated movements of the wrist or finger greater than 4 hours, somatisation tendency, and better physical health and well-being and wrist or hand pain in the past month in this final model.

DISCUSSION

Our study findings show that pain of the wrist or hand is prevalent among hospital nurses, with around 15% experiencing pain in the past month and more than 20% experiencing pain in the past 12 months. This pain was also found to be severe enough for 14% to take time off work and for 43% to seek medical advice over the past year. For pain in the past month, work factors were not found to be related to wrist or hand pain, but several physical and personal psychosocial determinants were associated. However, after adjustment for each other in a final model, only repeated movements of the wrist/fingers for more than 4 h, somatisation tendency, and better physical

---

**Table 1** Socio-demographic and anthropometric characteristics of the study participants with and without wrist or hand pain in the past month

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Wrist or hand pain</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes (n = 170)</td>
</tr>
<tr>
<td></td>
<td>% 15.3</td>
</tr>
<tr>
<td>Age, mean (SD)*</td>
<td>46.1*</td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
</tr>
<tr>
<td>&lt;30</td>
<td>11.4*</td>
</tr>
<tr>
<td>30–39</td>
<td>8.9</td>
</tr>
<tr>
<td>40–49</td>
<td>20.1</td>
</tr>
<tr>
<td>≥50</td>
<td>26.6</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>4.7</td>
</tr>
<tr>
<td>Female</td>
<td>95.3</td>
</tr>
<tr>
<td>Body mass index, kg/m²</td>
<td></td>
</tr>
<tr>
<td>Normal, &lt;25.0</td>
<td>45.2</td>
</tr>
<tr>
<td>Overweight, 25.0–29.9</td>
<td>32.5</td>
</tr>
<tr>
<td>Obese, ≥30.0</td>
<td>23.3</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
</tr>
<tr>
<td>Married/de facto</td>
<td>58.2</td>
</tr>
<tr>
<td>Single</td>
<td>25.9</td>
</tr>
<tr>
<td>Separated/divorced/widowed</td>
<td>15.9</td>
</tr>
<tr>
<td>Educational qualifications</td>
<td></td>
</tr>
<tr>
<td>Up to undergraduate</td>
<td>55.6</td>
</tr>
<tr>
<td>Postgraduate qualification</td>
<td>44.4</td>
</tr>
</tbody>
</table>

*Age as a continuous variable is presented as mean and SD.

---

health and well-being were found to be significantly associated with wrist or hand pain in the past month. The prevalence of self-reported wrist or hand pain in the past month in Australian nurses in our study was double that of recently reported data in Japanese nurses (7%).

Prevalence of MSDs has been noted to vary across occupational groups and over national boundaries. Another study had found that the prevalence of musculoskeletal symptoms and associated disability were different among Indians residing in UK and the Indian subcontinent. Subjectivity of terms, variations in disability were different among Indians residing in UK and the prevalence of musculoskeletal symptoms and associated over national boundaries. Another study had found that the prevalence of musculoskeletal symptoms and associated disability were different among Indians residing in UK and the Indian subcontinent. Subjectivity of terms, variations in disability were different among Indians residing in UK and the Indian subcontinent.

Repeated movement of the wrist or fingers for more than 4 h, but not the use of a keyboard, was significantly associated with wrist or hand pain in the past month. This further extends the findings of a previous study which found that repetitive motions with hands/wrist was associated with increased odds of reporting wrist or hand musculoskeletal symptoms in nurses working in operating theatres. Our findings indicate that while keyboard usage might not be a key factor, other activity involving the hand and wrist movement are important. While longitudinal studies would provide stronger evidence, our findings suggest that to prevent wrist or hand pain among hospital nurses there is a need to focus on reduction of time spent on repetitive wrist or hand movements, perhaps through the inclusion of supplementary breaks or more diverse schedules of duties.

Our study showed that somatisation tendency, a process by which psychological distress is expressed as physical symptoms, was significantly associated with wrist or hand pain among nurses. Our finding that somatising tendency is significantly associated with wrist or hand pain in the past month is consistent with a study from Japan of a group of nurses, postal workers and office workers.

We found that workplace psychosocial factors were not associated with self-reported wrist or hand pain in the past

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Univariate analysis</th>
<th>Multivariable analysis*</th>
<th>Multivariable analysis†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR (95% CI)</td>
<td>OR (95% CI)</td>
<td>OR (95% CI)</td>
</tr>
<tr>
<td>Employment status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full-time</td>
<td>1.00 (—)</td>
<td>1.00 (—)</td>
<td>1.00 (—)</td>
</tr>
<tr>
<td>Part-time/casual</td>
<td>1.02 (0.73 to 1.43)</td>
<td>0.89 (0.62 to 1.28)</td>
<td>0.79 (0.42 to 1.45)</td>
</tr>
<tr>
<td>Years in current job</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;5 years</td>
<td>1.00 (—)</td>
<td>1.00 (—)</td>
<td>1.00 (—)</td>
</tr>
<tr>
<td>≥5 years</td>
<td>1.71 (1.22 to 2.39)</td>
<td>1.21 (0.82 to 1.78)</td>
<td>1.20 (0.81 to 1.78)</td>
</tr>
<tr>
<td>No of hours/week</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;40 h/week</td>
<td>1.00 (—)</td>
<td>1.00 (—)</td>
<td>1.00 (—)</td>
</tr>
<tr>
<td>≥40 h/week</td>
<td>0.98 (0.70 to 1.37)</td>
<td>1.06 (0.74 to 1.54)</td>
<td>0.85 (0.46 to 1.59)</td>
</tr>
</tbody>
</table>

Bold values represent statistically significant Odds Ratio.

*ORs are adjusted for age, gender, BMI, employment status, years in current job and number of hours per week.

†ORs are adjusted for age, gender, BMI, listed workplace physical and psychosocial factors.

Table 3

<table>
<thead>
<tr>
<th>Factors</th>
<th>Participants self-reporting wrist or hand pain in the past month</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Univariate analysis</td>
</tr>
<tr>
<td></td>
<td>OR (95% CI)</td>
</tr>
<tr>
<td>Physical factors</td>
<td></td>
</tr>
<tr>
<td>Use of keyboard/ typewriter &gt;4 h</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1.00 (—)</td>
</tr>
<tr>
<td>Yes</td>
<td>1.19 (0.82 to 1.73)</td>
</tr>
<tr>
<td>Repeated movements of the wrist or finger &gt;4 h</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1.00 (—)</td>
</tr>
<tr>
<td>Yes</td>
<td>2.36 (1.70 to 3.29)</td>
</tr>
<tr>
<td>Psychosocial factors</td>
<td></td>
</tr>
<tr>
<td>Supervisor/co-worker support in the workplace</td>
<td></td>
</tr>
<tr>
<td>Often/sometimes</td>
<td>1.00 (—)</td>
</tr>
<tr>
<td>Seldom/never</td>
<td>1.14 (0.64 to 2.05)</td>
</tr>
<tr>
<td>Job satisfaction</td>
<td></td>
</tr>
<tr>
<td>Very satisfied/satisfied</td>
<td>1.00 (—)</td>
</tr>
<tr>
<td>Dissatisfied/very dissatisfied</td>
<td>1.25 (0.73 to 2.14)</td>
</tr>
<tr>
<td>Job security</td>
<td></td>
</tr>
<tr>
<td>Very safe/safe</td>
<td>1.00 (—)</td>
</tr>
<tr>
<td>Rather unsafe/unsafe</td>
<td>2.01 (1.36 to 2.97)</td>
</tr>
<tr>
<td>Job strain</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>1.00 (—)</td>
</tr>
<tr>
<td>High</td>
<td>1.51 (1.08 to 2.13)</td>
</tr>
</tbody>
</table>

Bold values represent statistically significant Odds Ratio.

*ORs are adjusted for age, gender, BMI, listed workplace physical and psychosocial factors.
Wrist or hand pain is highly prevalent in hospital nurses, resulting in considerable disability and absence from work. Sumatisation tendency was significantly associated with wrist or hand pain. Repeated movement of the wrist or finger was significantly associated with wrist or hand pain. Workplace psychosocial factors did not show any association in the final model.
importance of both personal and physical factors, particularly repeated movements for greater than 4 hours, somatising tendency, and physical health and well-being in occupational wrist and hand pain among nurses. We also found weaker evidence that job strain, job insecurity and pain catastrophising are factors to consider in association with wrist or hand pain in nurses. These factors need to be investigated further in longitudinal studies to determine whether they predict the development of wrist or hand pain in hospital-based nurses.

Acknowledgements We acknowledge the assistance from the CUPID international study team, led by Professors David Coggon and Keith Palmer, and a group based at the Medical Research Council Epidemiology Resource Centre, University of Southampton.

Contributors IKS conducted the statistical analysis and wrote the paper. VCVH developed the questionnaire, collected and cleaned the baseline and follow-up data, conducted the statistical analysis, and wrote the paper. HLK developed the questionnaire, liaised with the hospitals, collected the data for baseline and follow-up, advised on the analysis and edited the paper. DMU developed the questionnaire, advised on the analysis and edited the paper. MRS was the principal investigator, developed the questionnaire, advised on the analysis and edited the paper.

Funding Funding was received from the Monash University Strategic Grant Scheme and Monash University Near Miss Grant for NHMRC projects in 2008. IKS was supported by the Ministry of Health Sri Lanka. VCVH was supported by Ministry of Higher Education’s Academic Training Scheme, Malaysia. HLK was supported by a NHMRC Public Health Postdoctoral Fellowship (384354), Australia. DMU was supported by a NHMRC Career Development Fellowship (1011975), Australia.

Competing interests None. Ethical approval Monash University Human Research Ethics Committee and The Alfred Ethics Committee.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement The study is part of the the International Study of Physical, Cultural and Psychosocial Influences on Musculoskeletal Symptoms and Associated Disability (CUPID Study). In addition to the data presented in this manuscript, additional data included musculoskeletal pain from other sites (ie neck, shoulder, elbow, low back and knee), and the Back Beliefs Questionnaire and the GHQ12 questionnaire. The dataset is available to the authors of this manuscript and Monash Centre for Occupational and Environmental Health, researchers at the Monash Centre for Occupational and Environmental Health, Monash University, Melbourne, Australia. The CUPID international study team, Professors David Coggon and Keith Palmer from Medical Research Council Epidemiology Resource Centre, University of Southampton has been supplied with additional data included musculoskeletal pain from other sites (ie neck, shoulder, and back and functional consequences in nurses. 

REFERENCES


4. A prospective study of work ability and multiple sites musculoskeletal pain among female hospital based nurses.

4.1 Introduction

This chapter investigates the relationship between multisite musculoskeletal pain and self-perceived work ability. Besides neck pain and upper-limb pain, low back pain and knee pain were also included, as work ability is a general body state and a more general whole-body approach was required. The main analysis focuses on examining the relationship between musculoskeletal pain at baseline and the self-rated work ability at follow-up (12 months later). Recent research has established that one of the key reasons for nurses leaving the profession is low perceived work ability (Camerino et al., 2006). In addition a recent cross-sectional study has found that multisite MSDs were associated with poor work ability in the Finnish general working population (Miranda et al., 2010). As many developed countries (such as the United States of America, Europe and Australia) are experiencing nursing shortages, and it is predicted that this situation will deteriorate further in the future (Goodin, 2003, 2005), there is a need to increase retention in the current nursing workforce further into their career.

The paper in this chapter has been submitted to the Scandinavian Journal of Work, Environment & Health for consideration for publication.
4.2 Declaration for Thesis Chapter

Hoe VCW, Kelsall HL, Urquhart DM, Sim MR. A prospective study of work ability and multiple sites musculoskeletal pain among female hospital based nurses. Scand J Work Environ Health; submitted

Declaration by candidate

In the case of Chapter 4 the nature and extent of my contribution to the work was the following:

<table>
<thead>
<tr>
<th>Nature of contribution</th>
<th>Extent of contribution (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal author: Responsible for overall concept and design; development of the questionnaire; data collection; data cleaning; literature review; analysis; development and drafting of the submitted manuscript, and critical revision of the manuscript. Responsible author who accepts overall responsibility for the publication.</td>
<td>80%</td>
</tr>
</tbody>
</table>

The following co-authors contributed to the work. Co-authors who are students at Monash University must also indicate the extent of their contribution in percentage terms:

<table>
<thead>
<tr>
<th>Name</th>
<th>Nature of contribution</th>
<th>Extent of contribution (%) for student co-authors only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helen L Kelsall</td>
<td>Contributed to the drafting and critical revision of the manuscript; development of the study design, methods and questionnaire</td>
<td>N/A</td>
</tr>
<tr>
<td>Donna M Urquhart</td>
<td>Contributed to the drafting and critical revision of the manuscript; development of the questionnaire</td>
<td>N/A</td>
</tr>
<tr>
<td>Malcolm R Sim</td>
<td>Contributed to the drafting and critical revision of the manuscript; development of the study design, methods and questionnaire</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Candidate’s Signature

Date 02/11/2011

Declaration by co-authors

The undersigned hereby certify that:
(1) the above declaration correctly reflects the nature and extent of the candidate's contribution to this work, and the nature of the contribution of each of the co-authors.
(2) they meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;
(3) they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;
(4) there are no other authors of the publication according to these criteria;
(5) potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and
(6) the original data are stored at the following location(s) and will be held for at least five years from the date indicated below:

Location(s) | Monash University Department of Epidemiology and Preventive Medicine, Alfred Centre

Signature 1 | Date 2/11/11
Signature 2 | Date 2/11/11
Signature 3 | Date 2/11/11

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Chapter 4

A prospective study of work ability and multisite musculoskeletal pain among female hospital based nurses.

Abbreviated title: Study of work ability and multisite musculoskeletal pain

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Chapter 4

Abstract

Objective:

To investigate the relationship between multisite musculoskeletal pain and self-perceived work ability in hospital based nurses.

Methods:

Female nurses working across three major hospitals who were first surveyed 12 months ago were included. Information was collected on socio-demographic, lifestyle, mental health, personal, and workplace physical and psychosocial factors, musculoskeletal pain at several body sites for seven days or more in the previous 12 months and work ability. The association between multisite musculoskeletal pain and work ability was investigated using an ordinal logistic regression model.

Results:

Of 1,019 female baseline participants, 763 nurses (response rate 74.9%) completed the follow-up questionnaire. 262 participants reported less than excellent work ability, while 250 reported musculoskeletal pain at more than one body site. Pain at any site (OR 1.81; 95%CI 1.15–2.84), pain at two sites (2.18; 1.34–3.54), and pain at more than two sites (2.31; 1.42–3.78) were all associated with reduced work ability. Other risk factors associated with reduced work ability were being overweight (1.55; 1.05–2.30) or obese (1.85; 1.15–2.99), low job satisfaction (2.17; 1.23–3.85), poor mental health (2.84; 1.98–4.10), low resilience (1.71; 1.14–2.57) and pain catastrophising (1.94; 1.29–2.91).
Chapter 4

**Conclusion:**

Multisite musculoskeletal pain is common in nurses. Pain in one or more sites was found to predict reduced self-perceived work ability, with work ability reducing as the number of painful sites increased. Efforts to retain the current workforce and improve their work ability should include the prevention and management of musculoskeletal, as well as other anthropometric, work and psychosocial factors.

**Keywords:** musculoskeletal disorders, workplace, occupational, psychosocial factors, resilience, pain catastrophising
Chapter 4

Introduction

Many developed countries are experiencing nursing shortages, including the United States of America, Europe and Australia, and it is predicted that this situation will deteriorate further in the future [1, 2]. With the population ageing there has been an increase in the number of older individuals both in absolute number and proportion, which has further exacerbated the situation [3]. This has led to an increased need to care for the ageing population and to provide for an ageing nursing workforce. One of the solutions to address these shortages is to increase retention in the current nursing workforce.

One of the key reasons for nurses leaving the profession is low perceived work ability [4]. Work ability is a measure of a worker’s capacity to perform their work based on the work content and job demand. In addition, work capacity has also been found to be related to personal factors in the workers themselves, such as education, knowledge, skills, experience, motivation and health status [5, 6]. A systematic review has identified that factors associated with poor work ability include poor musculoskeletal capacity (reduce endurance and strength), older age, obesity, high mental work demands, lack of autonomy, poor physical work environment and high physical work load [7]. Moreover, a more recent study found that multisite musculoskeletal disorders were associated with poor work ability in the Finnish working population [8]. As musculoskeletal disorders are one of the most common occupational disorders among nursing personnel [9, 10], these may be a major contributor to reduced work ability in nurses and, in turn, lead them to leaving the nursing profession early.

The aim of this study is to investigate the relationship between multisite musculoskeletal pain and self-perceived work ability among female hospital based nurses in Melbourne, Australia. The study also aimed to investigate the influence of socio-demographic, anthropometric,
employment, personal and workplace physical and psychosocial factors on the relationship
between work ability and multisite musculoskeletal pain in nurses.

Methods

This study is the Australian arm of the International Study of Physical, Cultural and
Psychosocial Influences on Musculoskeletal Symptoms and Associated Disability (CUPID
Study) [11, 12]. This is a 12 month prospective study investigating factors associated with the
development and persistence of musculoskeletal pain. The current paper focuses on
musculoskeletal pain and other factors assessed during the baseline questionnaire and self-
rated work ability at follow-up (12 months later). The factors assessed during the baseline
questionnaire included socio-demographics, anthropometric, personal and employment
characteristics, mental health status, workplace physical and psychosocial factors, and
musculoskeletal pain at several body sites.

Study design and population

Nurses working across three major hospitals in Melbourne, Australia who were first surveyed
12 months ago (n=1,119) were included in this prospective study. The analyses in this paper
were limited to 1,019 females who participated at baseline, as the number of male
participants was small. The hospitals included a tertiary referral and teaching hospital, a
hospital providing mainly rehabilitation and aged care services, and a community based
hospital. The process for the follow-up study was similar to the baseline study; a personally
addressed invitation letter, an information booklet describing the study and the study
questionnaire were mailed to the study population, reminder letters and email/phone contact
was made to those who did not respond to the initial mailout, and the participants were
eligible to enter a draw for a chance to win one of 10 AUD 100 vouchers from a major department store [13].

**Outcome**

The main outcome for this analysis was self-rated work ability, which was assessed using a modified Work Ability Index (WAI) questionnaire [14]. The modified WAI questionnaire was derived from the six sections of the original WAI questionnaire, with the section on diseases diagnosed by a physician removed [15]. The six sections of the original WAI questionnaire assessed current work ability compared to lifetime best, work ability in relation to job demands, estimated work impairment due to diseases, sick leave during the past 12 months, own prognosis of work ability two years from now and mental resources. Scores range from 6 to 42, with a higher score indicating better work ability [14]. The work ability was categorised as excellent (37–42), good (30–36), and medium/poor (6–29). The original WAI has been found to be a highly predictive instrument of work ability in a nursing population and has a high level of cross-national stability [16].

**Determinants**

The questions on musculoskeletal symptoms were adapted from the Nordic Questionnaire on musculoskeletal complaints [17]. They were accompanied by anatomical diagrams depicting the specified sites. The participants were asked whether they had experienced pain in six anatomical sites (neck, shoulder, elbow, wrist/hand, low back and knee) lasting for more than seven days during the previous 12 months at baseline. Participants were categorised as experiencing no pain, pain at one site, pain at two sites and pain at more than two sites. Multisite pain was considered to be pain at more than one site.
Covariates

Normal weight was defined as a body mass index (BMI) of <25.00 kg/m², overweight as BMI 25.00–29.99 kg/m² and obesity as BMI ≥30.00 kg/m² [18]. Classification of alcohol consumption of greater than two standard drinks per day was based on the Australian National Health and Medical Research Council (NHMRC) Guidelines 2009 on lifetime risk of harm from drinking alcohol [19].

Workplace physical demands were measured using a dichotomous scale (No/Yes) for strenuous tasks during an average working day, and categorised as high if the participants reported experiencing four or more strenuous tasks. The strenuous tasks included use of keyboard or typewriter for more than four hours, other tasks involving repeated movement of the wrist or fingers for more than four hours, repeated bending and straightening of the elbow for longer than one hour, working for longer than one hour with the hands above shoulder height, lifting weights of 25 kg or more by hand, climbing up and down more than 30 flights of stairs, and kneeling or squatting for longer than one hour on an average working day.

Measures of workplace psychosocial factors were based on the job control and demand model [20]. The job control measure assessed the participant’s choice in deciding how to do the work, what to do at work and their work timetable and breaks, with response options of ‘often’, ‘sometimes’, ‘seldom’ and ‘never/almost never’. Job control was classified as ‘low’ when two or more responses were ‘never/almost never’. High job strain was defined as having low job control and working under time pressure. Questions were also asked about social support at work, job satisfaction and job security.

Mental health was assessed using the Mental Health Inventory-5 (MHI-5). The MHI-5 contains five items with a six-point scale (i.e., from ‘all of the time’ to ‘none of the time’).
Chapter 4

assessing how participants feel and have been during the past month [21]. The score was transformed into a variable ranging between 1 and 100, where a high score indicates better mental health, and a score of <76 (sensitivity 0.76, specificity 0.77) indicates the presence of the common mental disorders of anxiety and depression [22].

Resilience refers to the dynamic process of positive adaptation in the face of stress or trauma [23]. It was assessed using the 10-item Connor-Davidson Resilience Scale (CD-RISC) [24, 25]. The instrument contains 10-items on a scale from 0 (not true at all) to 4 (true nearly all the time). The total score ranges from 0−40, with higher scores reflecting greater resilience. Participants with a score ≤ 25th percentile were categorised as having low resilience.

Somatisation was measured using the somatisation sub-scale of the Brief Symptoms Inventory [26], and was classified according to the number of somatic symptoms that were rated as at least moderately distressing. Those who reported ≥ 2 of seven symptoms in the past seven days were considered as having somatisation tendency [27].

The Pain Catastrophizing Scale (PCS) [28] is a 13-item scale that measures the participant’s expression of worry and excessive focus on negative aspects of their painful situation, expectations of negative outcomes and the inability to cope effectively with pain [29]. The options range from ‘not at all’ (score of zero) to ‘all the time’ (score of four). The scores are summed and the total score ranges from 0−52. Pain catastrophising scores were categorised as high (≥75 percentile) and low (<75% percentile).
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**Statistical analysis**

The outcome measure was self-rated work ability during the follow-up. The association between independent variables at baseline and work ability at follow-up was investigated using an ordinal logistic regression model to estimate odds ratios (OR) with 95% confidence intervals (95% CI). The work ability categories were considered as ordinal variables, ordered from excellent to moderate/poor work ability. Compared to the traditional logistic regression, coefficients of this analysis take into account the two transitions from excellent to moderate/poor work ability. The proportional odds assumption was satisfied. In the models, odds ratios indicate the likelihood of passing from excellent to good, from good to moderate/poor work ability.

Two statistical models were considered in the analysis, the full and the parsimonious model. The full model consisted of all independent variables that were statistically significant (p<0.05) in the univariate analysis. The parsimonious model was derived using the likelihood ratio test, where variables were removed one at a time from the full model until the likelihood ratio chi-square test comparing the full and the simple model had a p-value <0.1. The analysis was conducted using STATA/IC 11 (StataCorp LP, College Station, Texas, USA) statistical software.
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Results

Of the 1,019 female baseline participants, 763 nurses (response rate 74.9%) completed the follow-up questionnaire. The main differences between the respondents and the non-respondents were that the respondents were older (mean age 42.9 vs. 38.0 years) and fewer worked full-time (33.8 vs. 41.6%). There was no differences in reporting of any musculoskeletal pain (64.7 vs. 64.1%), being overweight (28.6 vs. 28.2%) or obese (15.9 vs. 14.1%), and the remainder socio-demographic characteristics.

The majority of nurses reported excellent (n=467, 64.0%) to good (n=193, 26.5%) work ability, while 69 (9.5%) reported moderate/poor work ability. The comparison between the demographic, anthropometric and employment factors, and multisite musculoskeletal pain and work ability are presented in Table 1. Almost 40% of the nurses reported pain in more than one site, 146 (19.2%) reported pain in two sites and 149 (19.6%) in more than two sites. The most common site of pain lasting for seven days or more in the past 12 months was low back (38.3%), followed by neck (32.5%), shoulder (22.2%), knee (18.3%), wrist/hand (14.2%) and elbow (8.2%) pain. There was a greater proportion of overweight and obese participants, reporting multisite pain, and those 50 years or older among those who self-rated their work ability as moderate or poor.
Table 1: Socio-demographic, anthropometric and employment factors for different categories of work ability.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Excellent</th>
<th>Work Ability&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Moderate/Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Age, mean (SD) years&lt;sup&gt;*&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 30 years</td>
<td>63</td>
<td>13.6</td>
<td>24</td>
</tr>
<tr>
<td>30-39 years</td>
<td>126</td>
<td>27.2</td>
<td>65</td>
</tr>
<tr>
<td>40-49 years</td>
<td>145</td>
<td>31.2</td>
<td>42</td>
</tr>
<tr>
<td>≥ 50 years</td>
<td>130</td>
<td>28.0</td>
<td>62</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married/de facto</td>
<td>292</td>
<td>63.3</td>
<td>124</td>
</tr>
<tr>
<td>Single</td>
<td>115</td>
<td>24.9</td>
<td>45</td>
</tr>
<tr>
<td>Divorced/widowed</td>
<td>54</td>
<td>11.7</td>
<td>24</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal weight, &lt; 25.0</td>
<td>263</td>
<td>59.4</td>
<td>97</td>
</tr>
<tr>
<td>Overweight, 25.00 – 29.99</td>
<td>117</td>
<td>26.4</td>
<td>61</td>
</tr>
<tr>
<td>Obese, ≥ 30.00</td>
<td>63</td>
<td>14.2</td>
<td>26</td>
</tr>
<tr>
<td>Smoking status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never smoked</td>
<td>311</td>
<td>67.0</td>
<td>121</td>
</tr>
<tr>
<td>Ex-smoker</td>
<td>118</td>
<td>25.4</td>
<td>55</td>
</tr>
<tr>
<td>Current smoker</td>
<td>35</td>
<td>7.6</td>
<td>17</td>
</tr>
<tr>
<td>Alcohol consumption (on any day)&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤2 standard drinks per day</td>
<td>205</td>
<td>44.6</td>
<td>98</td>
</tr>
<tr>
<td>&gt; 2 standard drinks per day</td>
<td>255</td>
<td>55.4</td>
<td>93</td>
</tr>
<tr>
<td>Highest educational qualification</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to undergraduate</td>
<td>233</td>
<td>50.8</td>
<td>107</td>
</tr>
<tr>
<td>Post graduate up to PhD</td>
<td>226</td>
<td>49.2</td>
<td>85</td>
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<tr>
<td>Employment status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full-time</td>
<td>166</td>
<td>35.9</td>
<td>67</td>
</tr>
<tr>
<td>Part-time/casual</td>
<td>297</td>
<td>64.1</td>
<td>125</td>
</tr>
<tr>
<td>Working hours per week</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 40 hours</td>
<td>402</td>
<td>87.6</td>
<td>175</td>
</tr>
<tr>
<td>&gt; 40 hours</td>
<td>57</td>
<td>12.4</td>
<td>15</td>
</tr>
<tr>
<td>Year in current job</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 5 years</td>
<td>203</td>
<td>44.1</td>
<td>84</td>
</tr>
<tr>
<td>≥ 5 years</td>
<td>257</td>
<td>55.9</td>
<td>109</td>
</tr>
<tr>
<td>Number of sites of musculoskeletal pain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 site</td>
<td>210</td>
<td>47.3</td>
<td>34</td>
</tr>
<tr>
<td>1 site</td>
<td>128</td>
<td>28.8</td>
<td>53</td>
</tr>
<tr>
<td>2 sites</td>
<td>74</td>
<td>16.7</td>
<td>47</td>
</tr>
<tr>
<td>&gt; 2 sites</td>
<td>32</td>
<td>7.2</td>
<td>49</td>
</tr>
</tbody>
</table>

<sup>a</sup> Age as a continuous variable is presented as mean and standard deviation (SD)
<sup>b</sup> Based on NHMRC Guideline 2009 on lifetime risk of harm from drinking alcohol
<sup>b</sup> Work Ability was assessed at follow-up, other variables were assessed at baseline
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Table 2 shows that the risk of having reduced work ability increased with the increasing sites of musculoskeletal pain. There were no clear relationship with age and reduced work ability. Nurses who were overweight and obese were at greater risk of reduced work ability. Consuming more than two standard alcoholic drinks on any day was found to lower the risk for reduced work ability. Other socio-demographic and employment factors were not associated with reduced work ability.

Table 3 shows that the workplace physical and psychosocial factors, poor mental health, low resilience, pain catastrophising and somatisation tendency were all associated with reduced work ability. The strongest of these risk factors for reduced work ability were having low job satisfaction and poorer mental health.
Table 2: Association between socio-demographic, anthropometric and employment characteristics, and multisite musculoskeletal pain at baseline and reduced work ability at follow-up.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>n</th>
<th>OR\textsuperscript{a}</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, continuous (years)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 30 years</td>
<td>100</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td>30-39 years</td>
<td>203</td>
<td>0.93</td>
<td>0.57-1.51</td>
</tr>
<tr>
<td>40-49 years</td>
<td>197</td>
<td>0.57</td>
<td>0.34-0.95</td>
</tr>
<tr>
<td>≥ 50 years</td>
<td>226</td>
<td>1.26</td>
<td>0.78-2.03</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married/de facto</td>
<td>454</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td>Single</td>
<td>180</td>
<td>1.06</td>
<td>0.74-1.51</td>
</tr>
<tr>
<td>Divorced/widowed</td>
<td>89</td>
<td>1.22</td>
<td>0.77-1.92</td>
</tr>
<tr>
<td>Body mass index (kg/m\textsuperscript{2})</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal weight, &lt; 25.00</td>
<td>382</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td>Overweight, 25.00 - 29.99</td>
<td>201</td>
<td>1.63</td>
<td>1.15-2.30</td>
</tr>
<tr>
<td>Obese, ≥ 30.00</td>
<td>109</td>
<td>1.86</td>
<td>1.20-2.86</td>
</tr>
<tr>
<td>Smoking status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never smoked</td>
<td>472</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td>Ex-smoker</td>
<td>193</td>
<td>1.23</td>
<td>0.88-1.73</td>
</tr>
<tr>
<td>Current smokers</td>
<td>60</td>
<td>1.42</td>
<td>0.83-2.43</td>
</tr>
<tr>
<td>Alcohol consumption (on any day)\textsuperscript{b}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 2 standard drinks per day</td>
<td>341</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td>&gt; 2 standard drinks per day</td>
<td>377</td>
<td>0.71</td>
<td>0.53-0.96</td>
</tr>
<tr>
<td>Highest educational qualification</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to undergraduate</td>
<td>378</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td>Post graduate up to PhD</td>
<td>342</td>
<td>0.83</td>
<td>0.62-1.12</td>
</tr>
<tr>
<td>Employment status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full-time</td>
<td>249</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td>Part-time/casual</td>
<td>474</td>
<td>1.24</td>
<td>0.91-1.71</td>
</tr>
<tr>
<td>Working hours per week</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 40 hours</td>
<td>638</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td>&gt; 40 hours</td>
<td>79</td>
<td>0.68</td>
<td>0.41-1.14</td>
</tr>
<tr>
<td>Years in current job</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 5 years</td>
<td>315</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td>≥ 5 years</td>
<td>407</td>
<td>1.07</td>
<td>0.79-1.44</td>
</tr>
<tr>
<td>Number of sites of musculoskeletal pain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 site</td>
<td>249</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td>1 site</td>
<td>205</td>
<td>1.85</td>
<td>1.24-2.77</td>
</tr>
<tr>
<td>2 sites</td>
<td>135</td>
<td>2.36</td>
<td>1.53-3.63</td>
</tr>
<tr>
<td>&gt; 2 sites</td>
<td>102</td>
<td>3.21</td>
<td>2.09-4.92</td>
</tr>
</tbody>
</table>

\textsuperscript{a} Odds ratio was assessed using ordinal logistic regression model. The work ability categories were considered as ordinal variables, ordered from excellent to moderate/poor work ability.

\textsuperscript{b} Based on NHMRC Guideline 200 on lifetime risk of harm from drinking alcohol
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Table 3: Association between workplace physical and psychosocial factors, mental health, personal characteristics at baseline and reduced work ability at follow-up.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>n</th>
<th>OR^a</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workplace psychosocial factors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low social support</td>
<td>50</td>
<td>1.90</td>
<td>1.08-3.33</td>
</tr>
<tr>
<td>Low job satisfaction</td>
<td>59</td>
<td>4.17</td>
<td>2.49-6.99</td>
</tr>
<tr>
<td>Low job security</td>
<td>115</td>
<td>2.00</td>
<td>1.35-2.97</td>
</tr>
<tr>
<td>High job strain</td>
<td>72</td>
<td>2.03</td>
<td>1.28-3.24</td>
</tr>
<tr>
<td>High physical demand ^b</td>
<td>74</td>
<td>1.76</td>
<td>1.10-2.82</td>
</tr>
<tr>
<td>Poor mental health ^c</td>
<td>280</td>
<td>3.58</td>
<td>2.62-4.89</td>
</tr>
<tr>
<td>Low resilience ^d</td>
<td>171</td>
<td>2.90</td>
<td>2.07-4.06</td>
</tr>
<tr>
<td>Somatisation tendency ^e</td>
<td>95</td>
<td>1.71</td>
<td>1.12-2.61</td>
</tr>
<tr>
<td>Pain catastrophising tendency ^f</td>
<td>144</td>
<td>2.96</td>
<td>2.07-4.22</td>
</tr>
</tbody>
</table>

a. Odds ratio was assessed using an ordinal logistic regression model. The work ability categories were considered as ordinal variables, ordered from excellent to poor work ability.

b. Experiencing four or more strenuous tasks

c. Score of < 76 indicating common mental illness of anxiety and depression on MHI-5 scale.

d. Score of ≤ 25th percentile on 10-item Connor-Davidson Resilience Scale

e. Somatisation tendency defined as ≥2 symptoms out of 7 that were rated as at least moderately distressing.

f. Score of ≥ 75th percentile on Pain Catastrophizing Scale

Table 4 shows the multivariable models. The full model consists of all the variables that were significant in the univariate analysis and a parsimonious model assessed using the log likelihood ratio test. The categorical age groups were used in the multivariate models because the models explained more variability compared to age taken as a continuous variable.

Multisite musculoskeletal pain was found to be an independent risk factor for reduced work ability. The other independent risk factors associated with reduced work ability were being overweight and obese, low job satisfaction, poor mental health, low resilience, having at least one site of pain and pain catastrophising tendency. Alcohol consumption of more than two standard drinks on any day was found to be independently associated with a lower risk of reduced work ability.
Table 4: Multivariable model for the determinants of reduced work ability.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>OR&lt;sup&gt;a&lt;/sup&gt;</th>
<th>95% CI</th>
<th>OR&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 30 years</td>
<td>1.00</td>
<td>-</td>
<td>1.00</td>
</tr>
<tr>
<td>30-39 years</td>
<td>0.95</td>
<td>0.54-1.69</td>
<td>1.02</td>
</tr>
<tr>
<td>40-49 years</td>
<td>0.58</td>
<td>0.32-1.09</td>
<td>0.61</td>
</tr>
<tr>
<td>≥ 50 years</td>
<td>1.34</td>
<td>0.74-2.41</td>
<td>1.34</td>
</tr>
<tr>
<td>Body mass index (kg/m&lt;sup&gt;2&lt;/sup&gt;)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Normal weight, &lt; 25.0</td>
<td>1.00</td>
<td>-</td>
<td>1.00</td>
</tr>
<tr>
<td>Overweight, 25.00 – 29.99</td>
<td>1.58</td>
<td>1.05-2.36</td>
<td>1.55</td>
</tr>
<tr>
<td>Obese, ≥ 30</td>
<td>1.98</td>
<td>1.21-3.23</td>
<td>1.85</td>
</tr>
<tr>
<td>Alcohol consumption (on any day)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 2 standard drinks per day</td>
<td>1.00</td>
<td>-</td>
<td>1.00</td>
</tr>
<tr>
<td>&gt; 2 standard drinks per day</td>
<td>0.62</td>
<td>0.43-0.89</td>
<td>0.63</td>
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<td>Workplace psychosocial factors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low social support</td>
<td>1.24</td>
<td>0.63-2.45</td>
<td>-</td>
</tr>
<tr>
<td>Low job satisfaction</td>
<td>1.79</td>
<td>0.95-3.36</td>
<td>2.17</td>
</tr>
<tr>
<td>Low job security</td>
<td>1.34</td>
<td>0.83-2.16</td>
<td>-</td>
</tr>
<tr>
<td>High job strain</td>
<td>1.24</td>
<td>0.70-2.29</td>
<td>-</td>
</tr>
<tr>
<td>High physical demand&lt;sup&gt;d&lt;/sup&gt;</td>
<td>1.31</td>
<td>0.76-2.28</td>
<td>-</td>
</tr>
<tr>
<td>Poor mental health&lt;sup&gt;e&lt;/sup&gt;</td>
<td>3.05</td>
<td>2.08-4.46</td>
<td>2.84</td>
</tr>
<tr>
<td>Low resilience&lt;sup&gt;f&lt;/sup&gt;</td>
<td>1.75</td>
<td>1.15-2.66</td>
<td>1.71</td>
</tr>
<tr>
<td>Somatisation tendency&lt;sup&gt;g&lt;/sup&gt;</td>
<td>0.77</td>
<td>0.46-1.28</td>
<td>-</td>
</tr>
<tr>
<td>Pain catastrophising tendency&lt;sup&gt;h&lt;/sup&gt;</td>
<td>1.83</td>
<td>1.20-2.78</td>
<td>1.94</td>
</tr>
<tr>
<td>Number of sites of musculoskeletal pain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 site</td>
<td>1.00</td>
<td>-</td>
<td>1.00</td>
</tr>
<tr>
<td>1 site</td>
<td>1.80</td>
<td>1.13-2.86</td>
<td>1.81</td>
</tr>
<tr>
<td>2 sites</td>
<td>2.17</td>
<td>1.30-3.61</td>
<td>2.18</td>
</tr>
<tr>
<td>&gt; 2 sites</td>
<td>2.28</td>
<td>1.36-3.84</td>
<td>2.31</td>
</tr>
</tbody>
</table>

Odds ratio was assessed using ordinal logistic regression model, the work ability categories were considered as ordinal variables, ordered from excellent to poor work ability.

a. Odds ratio was mutually adjusted for all listed factors in the full model.
b. Odds ratio was mutually adjusted for all listed factors in the parsimonious model.
c. Based on NHMRC Guideline 200 on lifetime risk of harm from drinking alcohol
d. Experiencing four or more strenuous tasks
e. Score of < 76 indicating common mental illness of anxiety and depression on MHI-5 scale.
f. Score of ≤ 25th percentile on 10-item Connor-Davidson Resilience Scale
g. Somatisation tendency defined as ≥ 2 symptoms out of 7 that were rated as at least moderately distressing.
h. Score of ≥ 75th percentile on Pain Catastrophizing Scale.
Discussion

Work ability can be described as a measure of a worker’s capacity to perform his or her work based on work content and job demand [6]. More than 35% of the nurses reported having less than excellent work ability. Our study findings show that multisite musculoskeletal pain is a predictor of reduced work ability. The risk of reduced work ability increases with an increase in the number of painful sites, with those who had musculoskeletal pain in more than two sites reporting the highest risk. Our findings expand upon the results from an earlier cross-sectional study on a general working population in Finland [8] by showing in a longitudinal analysis that previously reported multiple sites of musculoskeletal pain were strongly associated with reduced self-perceived work ability one year later.

In our study we were able to examine socio-demographic, workplace physical and psychosocial, and employment factors that have previously been found to be associated with work ability and multiple sites of musculoskeletal pain [7, 12]. Besides those factors we were also able to examine other personal factors which were found to be associated with musculoskeletal pain; i.e. pain catastrophising tendency which has been found to be associated with low back pain [30], somatisation tendency and poorer mental health which has been found to be associated with multisite musculoskeletal pain [12, 13], as well as factors that may be associated with work ability; i.e. resilience. Even after adjusting for those covariates, multiple sites of musculoskeletal pain continued to be a strong risk factor for poorer work ability.

The other independent socio-demographic and work place risk factors for reduced work ability were being overweight or obese, low job satisfaction, and poor mental health, which provides further evidence for these risk factors examined in a systematic review [7]. In
addition, we found that personal factors, such as low resilience and a tendency for pain catastrophising, were associated with reduced work ability. We found that most workplace physical and psychosocial factors, except for job satisfaction, were not associated with reduced work ability. The findings were similar to a large study of European nurses where they found that work ability was associated with satisfaction and rewards [31]. However, it differs from studies in a German population which found high job strain due to high demand and low control was associated with poor work ability [32]. In our study, we also found that nurses who consume more than two standard alcoholic drinks on any day have lower risk of reduced work ability. While this finding suggests a predictive relationship between alcohol and work ability, it may also be an incidental finding requiring further investigation to understand the contribution of alcohol towards work ability.

Our study had several strengths. This is a prospective study with the determinants and covariates assessed during a baseline survey and the outcome variable for work ability assessed during follow-up at 12 months. The outcome variable of work ability was derived from the validated and internationally recognised WAI [14]. However, we did not include the section on the number of current diseases diagnosed by a physician, as the current study already included validated questions on musculoskeletal pain at several body sites, and the number of musculoskeletal pain sites would have overlapped with such an outcome variable. The questionnaires in this study on musculoskeletal disease, and physical and psychosocial factors have been used in previous studies [11, 12] and are validated instruments for the measurement of these risk factors; e.g. the BSI [26], PCS [28], CD-RISC [24, 25] and the MHI-5 [21]. We conducted a comprehensive promotional and recruitment strategy to maximise response and incentives, and achieved a satisfactory response rate of 75%.
Chapter 4

Our study had some limitations; we were unable to determine factors related to change in work ability over time as work ability outcome was only assessed during follow-up. The definition of having multiple sites pain in our study did not necessary imply that pain occurred simultaneously, only that each musculoskeletal pain had been reported for seven days or more in the past 12 months. Although the respondents were older and more were working part-time may influence the results, they have been addressed in the multivariate analysis.

This study found that multisite musculoskeletal pain is common in nurses and more than 35% of the nurses report having less than excellent work ability. Multisite musculoskeletal pain was found to be an important predictor of reduced work ability, with work ability reducing as the number of painful sites increased. These findings suggest that interventions to prevent and manage musculoskeletal disorders are likely to improve work ability and hence improve workforce retention.
ACKNOWLEDGEMENT

We acknowledge the assistance from the CUPID international study team, led by Professors David Coggon and Keith Palmer, and a group based at the Medical Research Council Epidemiology Resource Centre, University of Southampton.

COMPETING INTEREST

None.

FUNDING

Funding was received from the Monash University Strategic Grant Scheme and Monash University Near Miss Grant for NHMRC projects in 2008. VH was supported by Ministry of Higher Education's Academic Training Scheme, Malaysia. HK was supported by a NHMRC Public Health Postdoctoral Fellowship (384354), Australia. DU was supported by a NHMRC Career Development Fellowship (1011975), Australia.

ETHICAL APPROVAL

The study was approved by the Monash University Human Research Ethics Committee and The Alfred Ethics Committee.

AUTHORS CONTRIBUTION

VH – Developed the baseline and follow-up questionnaire, collected and cleaned the baseline and follow-up data, developed of the overall concept, hypothesis and analysis design of the paper.

HK – Developed the baseline and follow-up questionnaire, liaised with the hospitals, collected the data for baseline and follow-up, edited the paper.

DM - Developed the baseline and follow-up questionnaire, edited the paper.
Chapter 4

MS – Principal investigator, developed the baseline and follow-up questionnaire, edited the paper.
Chapter 4

Reference


Chapter 4


Chapter 4


Chapter 5

5. Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults (Cochrane Systematic Review Protocol).

5.1 Introduction

The focus of this and the following chapter is to review current literature on interventions focusing on physical and psychosocial factors to prevent work-related neck and upper limb disorders. Previous systematic reviews have concluded that there was some evidence to support the use of mechanical and modifier interventions for preventing and managing neck/upper extremity MSDs (Boocock et al., 2007). However the review only included papers published between 1999 and 2004 (Boocock et al., 2007), further the review included randomised control trials, and non-randomised trials which are at greater risk of bias. This thesis will extend and update the search period and consider all published and unpublished randomised trials on the effectiveness of ergonomic interventions for the prevention of work-related neck and upper limb disorders.

The topic of the review titled “Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults” was developed and registered with the Cochrane Bone Joint and Muscle Trauma Group within The Cochrane Collaboration. This chapter includes the peer-reviewed protocol for the process to retrieve and assess the available evidence on ergonomic intervention for preventing work-related neck and upper limb disorders. The development of the Cochrane protocol consisted of several steps, i.e., identifying the gap in the review topics, registering the title with the Cochrane
Chapter 5

Review Group, writing the protocol and developing the search strategy. The text and data of the protocol and review were entered into the Review Manager 5.1 software (RevMan, 2011).

This protocol chapter has been published in the Cochrane Library (Cochrane Database of Systematic Reviews. 2010;doi 10.1002/14651858.CD008570).
5.2 Declaration for Thesis Chapter


Declaration by candidate

In the case of Chapter 5 the nature and extent of my contribution to the work was the following:

<table>
<thead>
<tr>
<th>Nature of contribution</th>
<th>Extent of contribution (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal author. Responsible for initiating the systematic review; developing and</td>
<td>80%</td>
</tr>
<tr>
<td>securing the title of the review; establishing contacts with Cochrane Review Groups,</td>
<td></td>
</tr>
<tr>
<td>developing and drafting the submitted protocol, developing the search strategy, critical</td>
<td></td>
</tr>
<tr>
<td>revision of the protocol. Responsible author who accepts overall responsibility for the</td>
<td></td>
</tr>
<tr>
<td>protocol.</td>
<td></td>
</tr>
</tbody>
</table>

The following co-authors contributed to the work. Co-authors who are students at Monash University must also indicate the extent of their contribution in percentage terms:

<table>
<thead>
<tr>
<th>Name</th>
<th>Nature of contribution</th>
<th>Extent of contribution (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helen L Kelsall</td>
<td>Contributed to the drafting and critical revision of the protocol</td>
<td>N/A</td>
</tr>
<tr>
<td>Donna M Urquhart</td>
<td>Contributed to the drafting and critical revision of the protocol</td>
<td>N/A</td>
</tr>
<tr>
<td>Malcolm R Sim</td>
<td>Contributed to the drafting and critical revision of the protocol</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Candidate's Signature

Date 02/11/2011

Declaration by co-authors

The undersigned hereby certify that:

(1) the above declaration correctly reflects the nature and extent of the candidate's contribution to this work, and the nature of the contribution of each of the co-authors.

(2) they meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;

(3) they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;

(4) there are no other authors of the publication according to these criteria;

(5) potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and

(6) the original data are stored at the following location(s) and will be held for at least five years from the date indicated below:

Location(s) Monash University Department of Epidemiology and Preventive Medicine, Alfred Centre

Signature 1

Date 2/11/11

Signature 2

Date 2/11/11

Signature 3

Date 2/11/11

66
Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults (Protocol)

Hoe VCW, Kelsall HL, Urquhart DM, Sim MR

This is a reprint of a Cochrane protocol, prepared and maintained by The Cochrane Collaboration and published in The Cochrane Library 2010, Issue 9

http://www.thecochranelibrary.com
Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

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Editorial group: Cochrane Bone, Joint and Muscle Trauma Group.
Publication status and date: Edited (no change to conclusions), published in Issue 9, 2010.

Citation: Hoe VCW, Kelsall HL, Urquhart DM, Sim MR. Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults. Cochrane Database of Systematic Reviews 2010, Issue 7. Art. No.: CD008570. DOI: 10.1002/14651858.CD008570.

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ABSTRACT

This is the protocol for a review and there is no abstract. The objectives are as follows:

To assess the effects of workplace ergonomic design and/or training interventions for the prevention of work-related musculoskeletal disorders of the upper limb and neck in adults.

This review aims to make the following main comparisons:

1. Ergonomically designed equipment or environmental interventions versus no or placebo intervention;
2. Ergonomically designed equipment or environmental intervention versus another intervention;
3. Ergonomic training versus no or placebo training; and
4. A combination of ergonomically designed equipment or environmental interventions or ergonomic training versus a single intervention or a different combination of interventions.
BACKGROUND

Description of the condition

Work-related musculoskeletal disorders are the most common occupational disorders around the world, and have been recognised as a problem since the 17th century (Ramazzini 1964). Other general terms for these disorders include repetitive strain injury, occupational overuse syndrome and cumulative trauma disorders (Yassi 1997). Work-related upper limb musculoskeletal disorders (WRULDs) are work-related musculoskeletal disorders of the neck and upper limbs, which include the shoulders, upper arms, elbows, forearms, wrists and hands (Buckle 1999). These are also known as complaints of the arm, neck and/or shoulder (CANS) (Huisstede 2006). WRULDs can be divided into specific conditions with clear diagnostic criteria and pathological findings, which include tendon-related disorders (e.g. tendonitis), peripheral-nerve entrapment (e.g. carpal tunnel syndrome), neurovascular/vascular disorders (e.g. hand-arm vibration syndrome) and joint/joint- capsule disorders (e.g. osteoarthritis) or non-specific conditions where the main complaint is pain and/or tenderness with limited or no pathological findings (Buckle 1997; Yassi 1997).

The prevalence of WRULDs varies considerably across occupations and working populations. A review paper of epidemiological studies found the point prevalence of upper-extremity musculoskeletal disorders in workers ranged from 27% to 47%, and the 12-month prevalence ranged from 12% to 41% (Huisstede 2006). The annual prevalence of neck pain ranged from 19% to 48% (Buckle 1999; Core 2008). Other studies found the prevalence of upper limb pain in the working population to range from 12% to 30% (Bernard 1997; Buckle 1999; Engels 1996; Smith 2004). The reasons for the wide variance in the reported prevalence of WRULDs include: the absence of a universally accepted definition, the use of different diagnostic criteria (e.g. self reported or medical examination), and studies conducted on different populations (Buckle 1999; Huisstede 2006).

The estimated cost of WRULDs in the European Union is between 0.5% and 2% of gross national product (Buckle 1999). In Australia, disorders of the muscles, tendons and soft tissue (excluding back pain) are estimated to cost AUD519 million or 17% of the total health system costs (Mathers 1999). In the United Kingdom, musculoskeletal disorders were recorded as the second highest reason for sickness certification, with an average of 22.84 sickness certificates being issued per 1000 person years (Wynne-Jones 2009). In the United States, 52% of the total lost work days were due to musculoskeletal disorders, and in Sweden WRULDs constituted 15% of all sick-leave days and 18% of all sickness pensions (Buckle 1999).

The risk factors for developing WRULDs include individual factors (e.g. inadequate strength, poor posture), physical requirements at the workplace (e.g. work requiring prolonged static posture, highly repetitive work, use of vibrating tools), and organisational and psychosocial factors (e.g. poor work-rest cycle, shift work, low job security, little social support) (Bernard 1997; Buckle 1997; Marras 2009; NIOSH 2001; Shanahan 2006; Yassi 1997).

Description of the intervention

Ergonomics as defined by the International Ergonomics Association is the scientific discipline concerned with the understanding of the interactions among humans and other elements of a system. Ergonomics in the workplace refers to interactions among workers and other elements in the working environment. It is essentially about fitting the job to the worker.

Ergonomic design refers to the design of workplace equipment and the work environment; for example, equipment design (e.g. keyboard, mouse, hand tools), workplace design (e.g. work stations, visual display units, lighting), and job design (e.g. work pace, work-rest cycle).

Ergonomic training includes training in the identification of risk factors for WRULDs, proper work practice, selection of appropriate equipment, correct use of equipment and work station adjustment. Ergonomic design and training interventions have been heavily promoted for the prevention of WRULDs (NIOSH 1997; NIOSH 2001).

How the intervention might work

Many studies have found that ergonomic factors correlate with musculoskeletal symptoms (Bernard 1994; Bonfiglioli 2006; Ortiz-Hernandez 2003; Szeto 2009; Werner 2005). Adjusting ergonomic factors (such as the design of workplace equipment and/or the work environment) to reduce the physical and mental load on workers is likely to reduce the risk of workers developing WRULDs. For example, the use of a split keyboard has been found to reduce the severity of pain in computer users with musculoskeletal disorders (Tittiranonda 1999). Ergonomic training is also focused on modifying risk factors through education and empowerment of workers.

Why it is important to do this review

In a systematic review of interventions for the prevention and treatment of WRULDs, Boocock et al reviewed papers published between 1999 and 2004 (Boocock 2007). Boocock 2007 concluded that there was some evidence to support the use of mechanical and modifier interventions for preventing and managing neck/upper extremity musculoskeletal conditions. However, as well as randomised controlled trials, Boocock 2007 included other study designs that are at greater risk of bias. Our review will extend and update the search period and consider all published and unpublished randomised and quasi-randomised trials investigating the use of ergonomic design and training programs for the prevention of WRULDs.
OBJECTIVES

To assess the effects of workplace ergonomic design and/or training interventions for the prevention of work-related musculoskeletal disorders of the upper limb and neck in adults.

This review aims to make the following main comparisons:

1. Ergonomically designed equipment or environmental interventions versus no or placebo intervention;
2. Ergonomically designed equipment or environmental intervention versus another intervention;
3. Ergonomic training versus no or placebo training; and
4. A combination of ergonomically designed equipment or environmental interventions or ergonomic training versus a single intervention or a different combination of interventions.

METHODS

Criteria for considering studies for this review

Types of studies

Randomised controlled trials (RCTs), quasi-randomised trials (methods of allocating participants to a treatment which are not strictly at random; e.g. date of birth, hospital record number or alternative) and cluster RCTs (i.e. where the unit of randomisation is a group of people such as people working in the same office or shift rather than individual workers).

Types of participants

Participants are adults working at the time of the intervention, exposed to risk factors for WRULDs in their workplace. Because the review is focused on prevention of WRULDs, the majority of participants (around 75% or more) should be free of WRULDs at the time of the intervention. The study should be conducted in the workplace or work-related venues.

We will exclude studies evaluating treatment interventions for people with established WRULDs (this will be covered in the replacement review to Verhagen 2009), as well as those that focus on rehabilitation of people with acute or chronic conditions (e.g. trauma, neoplasm, and inflammatory or neurological diseases).

Types of interventions

Studies examining at least one ergonomic design and/or training intervention at the workplace aimed at the prevention of WRULDs will be included. Excluded will be studies testing ergonomic design and training for the treatment of individuals diagognosed with WRULDs or for prevention of WRULDs outside the workplace.

Interventions and specific comparisons to be made

The interventions will include the use of ergonomically designed equipment, ergonomically designed environment (including workplace and job design), ergonomic training and any combination of these. The interventions can be broadly classified as single interventions (e.g. special computer mouse/keyboard), multiple component interventions (e.g. special computer mouse/keyboard with ergonomic training) or multifactorial interventions (e.g. addressing several aspects/ risk factors at once).

The specific comparisons will include comparisons of: a single intervention versus another single intervention; multiple component interventions versus single interventions; and different multi-component or multifactorial interventions.

Types of outcome measures

Primary outcomes

The primary outcomes will be:
1. Number of people with newly diagnosed or verified WRULDs (incident cases).
2. Complaints or symptoms of pain or discomfort in the upper limb and/or neck using a dichotomy scale (e.g. yes/no), Likert scale, visual analogue scale or any similar scale measuring pain or discomfort.
3. Work-related function as measured by number of work days lost, loss of or change in job, work disability and level of functioning. For the lattermost, preference will be given to validated outcome measures (e.g. DASH: Disability of the Arm, Shoulder, and Hand questionnaire (Kitis 2009))

Secondary outcomes

Secondary outcomes will include change in productivity, costs (including costs of implementation of the intervention and treatment/rehabilitation costs for workers with pain/disability) and compliance (attitude and practice).

Search methods for identification of studies

Electronic searches

We will search the Cochrane Bone, Joint and Muscle Trauma Group Specialised Register (to present), the Cochrane Occupational Health Field’s Register (to present), the Cochrane Central Register of Controlled Trials (The Cochrane Library, current issue), MEDLINE (1950 to present), EMBASE (1980 to present)
The following websites will be searched to identify additional unpublished and ongoing studies: World Health Organization International Clinical Trials Registry Platform; Current Controlled Trials; Centre Watch; Trials Central; UK National Research Register (NRR) Archive; and the USA Centers for Disease Control and Prevention’s National Institute for Occupational Safety and Health (NIOSH) website. No language restrictions will be applied.

In MEDLINE, the search strategy will be combined with the sensitivity- and precision-maximising version of the Cochrane Highly Sensitive Search Strategy for identifying randomised controlled trials (Lefebvre 2009) (see Appendix 1). The search strategy will be modified for use in other databases.

**Searching other resources**

We will contact experts in the field to identify theses and unpublished studies. We will look for additional studies by checking the bibliographies of relevant articles.

**Data collection and analysis**

**Selection of studies**

Two review authors (VCWH and MRS) will obtain and screen abstracts and citations identified by the searches. The review authors will retrieve full text articles independently to identify any that may describe eligible studies and perform independent study selection. Any disagreement will be resolved by discussion. A third author (HLK) will be consulted if disagreement persists. Where there is uncertainty, we will contact the corresponding author to ascertain whether a potentially relevant study meets the review inclusion criteria.

**Data extraction and management**

Data extraction will be performed independently by two review authors (VCWH and DMU), with checks for discrepancies and processing as described in the Cochrane Handbook. Discrepancies will be resolved by consensus. If consensus cannot be reached, a third author (HLK) will be asked to adjudicate. A standard data extraction form will be used, based on the form recommended by the Cochrane Bone, Joint and Muscle Trauma Group. All statistical analysis will be performed using Review Manager 5 (RevMan 2008) software.

We will contact corresponding authors to obtain further information on study methods and relevant unpublished data, such as summary statistics, if these are not included in the published reports.

**Assessment of risk of bias in included studies**

The risk of bias of included studies will be independently assessed by two review authors (VCWH and DMU), using The Cochrane Collaboration’s ‘Risk of bias’ tool (Appendix 2) (Higgins 2009). We will assess the risk of bias associated with a) blinding and b) completeness of outcomes for self-reported outcomes and objective outcomes separately. Each study will be graded for risk of bias in each of the following domains: sequence generation, allocation concealment, blinding, incomplete outcome data, selective outcome reporting and ‘other’ such as contamination bias. Disagreements between authors regarding the risk of bias for domains will be resolved by consensus. A risk of bias table will be generated for each study (Higgins 2009).

**Measures of treatment effect**

Quantitative outcome data given in individual trial reports will be presented in the text and in the analyses. Risk ratios with 95% confidence intervals (95% CI) will be calculated for dichotomous outcomes. Mean differences with 95% CI will be calculated for continuous outcomes, unless studies report different outcome measures, in which case standardised mean differences with 95% CI will be calculated.

**Unit of analysis issues**

In some trials, the unit of randomisation may be a group of people, such as people working in the same office or shift, rather than individual workers. The data from such cluster-randomised trials will be included in the meta-analysis only if it is possible to make an appropriate correction for the clustering. If that is not possible, their results will be reported in the text only.

**Dealing with missing data**

Where appropriate, intention-to-treat analyses will be performed to include all people randomised to the intervention groups. The effect of drop outs and exclusions will be investigated, initially by conducting worst and best scenario analyses. Unless missing standard deviations can be derived from standard errors or confidence interval data, we will not assume values in order to present these in the analyses.

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Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults (Protocol) 4
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Assessment of heterogeneity
Heterogeneity will be assessed by visual inspection of the forest plot (analysis) along with consideration of the test for heterogeneity and the I² statistic (Higgins 2003).

Assessment of reporting biases
If sufficient data are available, assessment of publication bias will be performed using a funnel plot.

Data synthesis
If data are available and if considered appropriate, results of comparable groups of studies will be pooled. The judgement of suitability for pooling will include consideration of the comparability of the interventions being compared, the setting (e.g. office, assembly line), the type of job (e.g. VDU operator, assembly line, manual worker), and outcome measures and measurement (e.g. timing of follow-up). Initially the fixed-effect model and 95% CIs will be used. The random-effects model will be considered where there is unexplained heterogeneity.

Subgroup analysis and investigation of heterogeneity
Where decisions have been taken to pool data from trials testing similar comparisons of interventions, we will consider subgroup analyses based primarily on:
1. type of participant occupation: for example, participants’ jobs primarily involving use of computer terminals/visual display units, manual handling jobs primarily involving carrying and lifting, manual handling jobs primarily working with hand tools, manual handling jobs primarily involving working above shoulder height;
2. type of setting: for example, office setting, factory or assembly line setting, outdoor setting;
3. gender
4. rigour of outcome measurement (e.g. active surveillance with verification versus less satisfactory methods)
Test of interaction will be used to establish whether the subgroups are statistically significantly different from one another (Altman 2003).

Sensitivity analysis
Where possible, sensitivity analyses will be conducted to examine various aspects of trial and review methodology, including the effects of missing data, study quality (specifically allocation concealment and outcome assessor blinding), and inclusion of studies only reported in abstracts or unpublished reports.

ACKNOWLEDGEMENTS
The authors would like to thank Dr Helen Handoll, Professor Jos Verbeek and Mrs Lindsey Elstub for valuable editorial comments on the protocol, Mrs Lesley Gillespie for assistance in developing the search strategies and the editorial staff of both the Cochrane Bone, Joint and Muscle Trauma Group and Cochrane Occupational Health Field.

REFERENCES

Additional references

Altman 2003

Bernard 1994

Bernard 1997

Bonfiglioli 2006

Boocock 2007

Buckle 1997

Buckle 1999

Cote 2008
Appendix 1. Search strategies

The Cochrane Central Register of Controlled Trials (Wiley InterScience interface)

#1 MeSH descriptor Cumulative Trauma Disorders explode all trees
#2 MeSH descriptor Occupational Diseases, this term only
#3 MeSH descriptor Hand-Arm Vibration Syndrome, this term only
#4 MeSH descriptor Occupational Health, this term only
#5 ((occupational overuse or tension neck) NEXT syndrome):ti,ab
#6 (cumulative trauma*:ti,ab
#7 (work related):ti,ab
#8 (repetit* NEXT (strain or stress or industr* or motion or movement or trauma)):ti,ab
#9 (vibration NEXT (induced or related or syndrome*)):ti,ab
#10 (#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9)
#11 MeSH descriptor Neck Pain, this term only
#12 MeSH descriptor Shoulder Pain, this term only
#13 MeSH descriptor Hand Injuries explode all trees
#14 MeSH descriptor Wrist Injuries, this term only
#15 MeSH descriptor Musculoskeletal Diseases, this term only
#16 (neck* or shoulder* or arm* or upper limb* or upper extremit* or elbow* or forearm* or wrist* or hand* or finger*:ti,ab
#17 (carpal tunnel syndrome*:ti,ab
#18 (#11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17)
#19 (#10 AND #18)
#20 MeSH descriptor Human Engineering explode all trees
#21 MeSH descriptor Biomechanics, this term only
#22 MeSH descriptor Movement, this term only
#23 MeSH descriptor Posture, this term only
#24 MeSH descriptor Mechanical Processes explode all trees
#25 MeSH descriptor Workload, this term only
#26 MeSH descriptor Workplace, this term only
#27 MeSH descriptor Equipment Design, this term only
#28 MeSH descriptor User-Computer Interface, this term only
#29 (ergonom* or biomechanic* or design or train* or environment* or equipment or computer* or keyboard* or VDU* or workplace or workstation):ti,ab
#30 (#20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29)
#31 (#19 AND #30)

MEDLINE (Ovid interface)

1. exp Cumulative Trauma Disorders/
2. Occupational Diseases/ or Hand-Arm Vibration Syndrome/
3. Occupational Health/
4. ((occupational overuse or tension neck) adj syndrome).tw.
Appendix 2. Risk of bias tool

<table>
<thead>
<tr>
<th>Domain</th>
<th>Description</th>
<th>Review authors’ judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sequence generation</td>
<td>Describe the method used to generate the allocation sequence in sufficient detail to allow an assessment of whether it should produce comparable groups.</td>
<td>Was the allocation sequence adequately generated? Yes/ No/ Unclear</td>
</tr>
<tr>
<td>Allocation concealment</td>
<td>Describe the method used to conceal the allocation sequence in sufficient detail to determine whether intervention allocations could have been foreseen in advance of, or during, enrolment.</td>
<td>Was allocation adequately concealed? Yes/ No/ Unclear</td>
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### Blinding of participants, personnel and outcome assessors

Assessments should be made for each main outcome (or class of outcomes).

Describe all measures used, if any, to blind study participants and personnel from knowledge of which intervention a participant received. Provide any information relating to whether the intended blinding was effective.

Was knowledge of the allocated intervention adequately prevented during the study?

Yes/ No/ Unclear

### Incomplete outcome data

Assessments should be made for each main outcome (or class of outcomes).

Describe the completeness of outcome data for each main outcome, including attrition and exclusions from the analysis. State whether attrition and exclusions were reported, the numbers in each intervention group (compared with total randomised participants), reasons for attrition/exclusions where reported, and any re-inclusions in analyses performed by the review authors.

Were incomplete outcome data adequately addressed?

Yes/ No/ Unclear

### Selective outcome reporting

State how the possibility of selective outcome reporting was examined by the review authors, and what was found.

Are reports of the study free of suggestion of selective outcome reporting?

Yes/ No/ Unclear

### Other sources of bias

State any important concerns about bias not addressed in the other domains in the tool.

If particular questions/entries were prespecified in the review’s protocol, responses should be provided for each question/entry.

Was the study apparently free of other problems that could put it at a high risk of bias?

Yes/ No/ Unclear

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**WHAT’S NEW**

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<td>28 July 2010</td>
<td>Amended</td>
<td>The order of the authors has been amended.</td>
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HISTORY

Protocol first published: Issue 7, 2010

CONTRIBUTIONS OF AUTHORS

The principal author (VCWH) initiated and planned the review. All authors (VCWH, HLK, DMU and MRS) were involved in writing the protocol. The principal author (VCWH) developed the search strategy in association with Lesley Gillespie of the Cochrane Bone, Joint and Muscle Trauma Group.

DECLARATIONS OF INTEREST

None known.

SOURCES OF SUPPORT

Internal sources

• University of Malaya, Kuala Lumpur, Malaysia.
• Department of Epidemiology & Preventive Medicine, Monash University, Melbourne, Australia.

External sources

• Ministry of Higher Education’s Academic Training Scheme, Malaysia.
• National Health and Medical Research Council’s Public Health Postdoctoral Fellowship, Australia.
• National Health and Medical Research Council’s Public Health Capacity Building Grant, Australia.
6. Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults (Intervention review).

6.1 Introduction

In the previous chapter we presented the peer-reviewed and published Protocol for “Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults”.

This chapter will focus on the conduct and the results of the systematic review. The conduct of the Cochrane review is a comprehensive process and consisted of several standardised steps, i.e., selection of studies, data extraction and management, assessment of risk of bias in included studies, measurement of treatment effect (including meta analysis), assessment of heterogeneity, assessment of the overall quality of the evidence for the primary outcomes by GRADE (Grading of Recommendations Assessment, Development and Evaluation) approach (Guyatt et al., 2011) using GRADEpro software (GRADEpro, 2007), and writing the review. During conduct of the systematic review, our review was deemed to be more appropriate to be included in the newly formed Cochrane Occupational Safety and Health Group and was transferred. The protocol remained as published and this did not materially affect the development of the review.

This chapter has been published in the Cochrane Library.
6.2 Declaration for Thesis Chapter

Hoe V, Urquhart DM, Kelsall HL, Sim MR. Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults (intervention review). Cochrane Database of Systematic Reviews [submitted]

Declaration by candidate

In the case of Chapter 6 the nature and extent of my contribution to the work was the following:

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<th>Nature of contribution</th>
<th>Extent of contribution (%)</th>
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<tr>
<td>Principal author: Responsible for initiating and planning the systematic review, administering the review process, liaison with the Cochrane Review Groups including during a period of transition; communication with the Australasian Cochrane Centre to clarify requirements and undergo training; participating in the decision-making process regarding the inclusion and exclusion of the studies; data extraction; risk of bias assessment; data synthesis; analysis; GRADE quality assessment; developing and drafting and critical revision of the manuscript, overall interpretation. Responsible author who accepts overall responsibility for the systematic review and for updating the review every two years.</td>
<td>80%</td>
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The following co-authors contributed to the work. Co-authors who are students at Monash University must also indicate the extent of their contribution in percentage terms:

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<tr>
<th>Name</th>
<th>Nature of contribution</th>
<th>Extent of contribution (%) for student co-authors only</th>
</tr>
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<tbody>
<tr>
<td>Donna M Urquhart</td>
<td>Contributed to the drafting and critical revision of the review and advice during the process; data extraction and risk of bias assessment, interpretation.</td>
<td>N/A</td>
</tr>
<tr>
<td>Helen L Kelsall</td>
<td>Contributed to the drafting and critical revision of the review, interpretation.</td>
<td>N/A</td>
</tr>
<tr>
<td>Malcolm R Sim</td>
<td>Contributed to the drafting and critical revision of the review, interpretation; decision making process regarding the inclusion and exclusion of the studies.</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Candidate’s Signature [Redacted] Date 2/11/2011

Declarations by co-authors

The undersigned hereby certify that:

(1) the above declaration correctly reflects the nature and extent of the candidate’s contribution to this work, and the nature of the contribution of each of the co-authors.
(2) they meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;
(3) they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;
(4) there are no other authors of the publication according to these criteria;
(5) potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and
(6) the original data are stored at the following location(s) and will be held for at least five years from the date indicated below:

Location(s) Monash University Department of Epidemiology and Preventive Medicine, Alfred Centre

Signature 1 [Redacted] Date 2/11/11
Signature 2 [Redacted] Date 2/11/11
Signature 3 [Redacted] Date 2/11/11
Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults (Review)

Hoe VCW, Urquhart DM, Kelsall HL, Sim MR

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Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults (Review)
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Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

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Editorial group: Cochrane Occupational Safety and Health Group.
Review content assessed as up-to-date: 31 October 2010.


ABSTRACT

Background

Work-related upper limb and neck musculoskeletal disorders (MSDs) are one of the most common occupational disorders around the world. Although ergonomic design and training are likely to reduce the risk of workers developing work-related upper limb and neck MSDs, the evidence is unclear.

Objectives

To assess the effects of workplace ergonomic design or training interventions, or both, for the prevention of work-related upper limb and neck MSDs in adults.

Search methods

We searched MEDLINE, EMBASE, the Cochrane Central Register of Controlled Trials (CENTRAL), CINAHL, AMED, Web of Science (Science Citation Index), SPORTDiscus, Cochrane Occupational Safety and Health Review Group Database and Cochrane Bone, Joint and Muscle Trauma Group Specialised Register to July 2010, and Physiotherapy Evidence Database, US Centers for Disease Control and Prevention, the National Institute for Occupational Safety and Health database, and International Occupational Safety and Health Information Centre database to November 2010.

Selection criteria

We included randomised controlled trials (RCTs) of ergonomic workplace interventions for preventing work-related upper limb and neck MSDs. We included only studies with a baseline prevalence of MSDs of the upper limb or neck, or both, of less than 25%.

Data collection and analysis

Two review authors independently extracted data and assessed risk of bias. We included studies with relevant data that we judged to be sufficiently homogeneous regarding the intervention and outcome in the meta-analysis. We assessed the overall quality of the evidence for each comparison using the GRADE approach.
Main results

We included 13 RCTs (2397 workers). Eleven studies were conducted in an office environment and two in a healthcare setting. We judged one study to have a low risk of bias. The 13 studies evaluated effectiveness of ergonomic equipment, supplementary breaks or reduced work hours, ergonomic training, a combination of ergonomic training and equipment, and patient lifting interventions for preventing work-related MSDs of the upper limb and neck in adults.

Overall, there was moderate-quality evidence that arm support with alternative mouse reduced the incidence of neck/shoulder disorders (risk ratio (RR) 0.52; 95% confidence interval (CI) 0.27 to 0.99) but not the incidence of right upper limb MSDs (RR 0.73; 95% CI 0.32 to 1.66); and low-quality evidence that this intervention reduced neck/shoulder discomfort (standardised mean difference (SMD) -0.41; 95% CI -0.69 to -0.12) and right upper limb discomfort (SMD -0.34; 95% CI -0.63 to -0.06).

There was also moderate-quality evidence that the incidence of neck/shoulder and right upper limb disorders were not reduced when comparing alternative mouse and conventional mouse (neck/shoulder RR 0.62; 95% CI 0.19 to 2.00; right upper limb RR 0.91; 95% CI 0.48 to 1.72), arm support and no arm support with conventional mouse (neck/shoulder RR 0.67; 95% CI 0.36 to 1.24; right upper limb RR 1.09; 95% CI 0.51 to 2.29), and alternative mouse with arm support and conventional mouse with arm support (neck/shoulder RR 0.58; 95% CI 0.30 to 1.12; right upper limb RR 0.92; 95% CI 0.36 to 2.36).

There was low-quality evidence that using an alternative mouse with arm support compared to conventional mouse with arm support reduced neck/shoulder discomfort (SMD -0.39; 95% CI -0.67 to -0.10). There was low- to very low-quality evidence that other interventions were not effective in reducing work-related upper limb and neck MSDs in adults.

Authors’ conclusions

We found moderate-quality evidence to suggest that the use of arm support with alternative mouse may reduce the incidence of neck/shoulder MSDs, but not right upper limb MSDs. Moreover, we found moderate-quality evidence to suggest that the incidence of neck/shoulder and right upper limb MSDs is not reduced when comparing alternative and conventional mouse with and without arm support. However, given there were multiple comparisons made involving a number of interventions and outcomes, high-quality evidence is needed to determine the effectiveness of these interventions clearly. While we found very-low- to low-quality evidence to suggest that other ergonomic interventions do not prevent work-related MSDs of the upper limb and neck, this was limited by the paucity and heterogeneity of available studies. This review highlights the need for high-quality RCTs examining the prevention of MSDs of the upper limb and neck.

Plain Language Summary

Ergonomic intervention for preventing work-related musculoskeletal disorders of the upper limb and neck.

Work-related musculoskeletal disorders of the upper limb and neck are one of the most common occupational disorders around the world. It is likely that addressing ergonomic factors, such as the design of workplace equipment or the environment, or both, as well as training workers in ergonomic principles may reduce the risk of workers developing these musculoskeletal disorders. This Cochrane review presents what we know from research about the effect of workplace ergonomic interventions for preventing work-related musculoskeletal disorders of the upper limb and neck.

We included 13 studies involving 2397 workers in this systematic review. We judged one study to have a low risk of bias. Four studies evaluated the effectiveness of ergonomically designed equipment, and four studies evaluated the effectiveness of breaks or reduced work hours in preventing work-related musculoskeletal disorders of the upper limb and neck. A further three studies evaluated the effectiveness of training in ergonomic principles and techniques, while one study evaluated this training in combination with ergonomically designed equipment and one study evaluated the effectiveness of a safe lifting intervention.

The results of this review suggest that the use of arm support together with an alternative mouse may prevent work-related musculoskeletal disorders of the neck and shoulder but not those of the right upper limb. The use of arm support alone or alternative mouse alone is not effective. However, given there were multiple comparisons made involving a number of interventions and outcomes, more high-quality research is needed to determine the effectiveness of these interventions clearly. This review was not able to determine the effectiveness of other ergonomic interventions for preventing musculoskeletal disorder of the upper limb and neck.
### Summary of Findings for the Main Comparison

**Patient or population:** patients with work-related musculoskeletal disorders of the upper limb and neck in adults  
**Settings:** VDU users (> 20 hours per week)  
**Intervention:** arm support with alternative mouse  
**Comparison:** conventional mouse alone (no arm support)

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Illustrative comparative risks* (95% CI)</th>
<th>Relative effect (95% CI)</th>
<th>No of participants (studies)</th>
<th>Quality of the evidence (GRADE)</th>
<th>Comments</th>
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</thead>
</table>
| **Incidence of upper body disorders (neck, shoulder, and upper extremity)** | Study population                        | RR 0.66 (0.42 to 1.04)   | 191 (2 studies)             | ⊕⊕⊕ moderate
|                                                   | Conventional mouse alone                | 333 per 1000 (140 to 347) |                             |                                 |                    |
|                                                   | Arm support with alternative mouse      | 220 per 1000 (140 to 347) |                             |                                 |                    |
|                                                   | Questionnaire followed by medical examination |                      |                             |                                 |                    |
|                                                   | Follow-up: 12 months                    |                          |                             |                                 |                    |
| **Incidence of neck/shoulder disorder**           | Study population                        | RR 0.52 (0.27 to 0.99)   | 186 (2 studies)             | ⊕⊕⊕ moderate
<p>|                                                   | Conventional mouse alone                | 232 per 1000 (63 to 229) |                             |                                 |                    |
|                                                   | Arm support with alternative mouse      | 120 per 1000 (63 to 229) |                             |                                 |                    |
|                                                   | Questionnaire followed by medical examination |                  |                             |                                 |                    |
|                                                   | Follow-up: 12 months                    |                          |                             |                                 |                    |</p>
<table>
<thead>
<tr>
<th>Incidence of right upper extremity disorder</th>
<th>Study population</th>
<th>RR 0.73 (0.32 to 1.66)</th>
<th>181 (2 studies)</th>
<th>⊕⊕⊕ moderate¹</th>
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<td>Questionnaire followed by medical examination</td>
<td>174 per 1000</td>
<td>127 per 1000 (56 to 289)</td>
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<tr>
<td>Follow-up: 12 months</td>
<td>Moderate</td>
<td>174 per 1000</td>
<td>127 per 1000 (56 to 289)</td>
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<th>Neck/shoulder discomfort score</th>
<th>The mean neck/shoulder discomfort score in the intervention groups was 0.41 standard deviations lower (0.69 to 0.12 lower)</th>
<th>194 (2 studies)</th>
<th>⊕⊕⊕ low¹,²</th>
<th>SMD -0.41 (-0.69 to -0.12)</th>
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<td>Questionnaire Follow-up: 12 months</td>
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<tr>
<th>Right upper extremity disorder</th>
<th>The mean right upper extremity disorder in the intervention groups was 0.34 standard deviations lower (0.63 to 0.06 lower)</th>
<th>194 (2 studies)</th>
<th>⊕⊕⊕ low¹,²</th>
<th>SMD -0.34 (-0.63 to -0.06)</th>
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<td>Questionnaire Follow-up: 12 months</td>
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* The basis for the assumed risk (e.g. the median control group risk across studies) is provided in footnotes. The corresponding risk (and its 95% CI) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).

CI: confidence interval; RR: risk ratio; VDU: visual display unit.

GRADE Working Group grades of evidence

**High quality:** Further research is very unlikely to change our confidence in the estimate of effect.

**Moderate quality:** Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.

**Low quality:** Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.

**Very low quality:** We are very uncertain about the estimate.

¹ Total number of participants <300 (small sample size for categorical variable)

² Measure of outcome was based on subjective symptoms (detection bias)
BACKGROUND

Description of the condition

Work-related musculoskeletal disorders (MSDs) are the most common occupational disorders around the world, and have been recognised as a problem since the 17th century (Ramazzini 1964). Other general terms for these disorders include repetitive strain injury, occupational overuse syndrome and cumulative trauma disorders (Yassi 1997). Work-related upper limb musculoskeletal disorders (WRULDs) are MSDs of the neck and upper limbs, which include the shoulders, upper arms, elbows, forearms, wrists, and hands (Buckle 1999). These are also known as complaints of the arm, neck and/or shoulder (CANS) (Huisstede 2006). WRULDs can be divided into specific conditions with clear diagnostic criteria and pathological findings, which include tendon-related disorders (e.g. tendonitis), peripheral-nerve entrapment (e.g. carpal tunnel syndrome), neurovascular/vascular disorders (e.g. hand-arm vibration syndrome), and joint/joint-capsule disorders (e.g. osteoarthritis) or non-specific conditions where the main complaint is pain or tenderness, or both, with limited or no pathological findings (Buckle 1997; Yassi 1997).

The prevalence of WRULDs varies considerably across occupations and working populations. According to a review of epidemiological studies from 1966 to June 2004 the point prevalence of upper-extremity MSDs in workers ranged from 30% to 47%, and the 12-month prevalence ranged from 12% to 41% worldwide (Huisstede 2006). The annual prevalence of neck pain in the working population ranged from 19% to 48% (Buckle 1999; Cote 2008). Other studies found the prevalence of upper limb pain in the working population to range from 12% to 30% (Bernard 1997; Buckle 1999; Engels 1996; Smith 2004). The reasons for the wide variance in the reported prevalence of WRULDs include: the absence of a universally accepted definition, the use of different diagnostic criteria (e.g. self-reported or medical examination), and different populations (Buckle 1999; Huisstede 2006). The cost of WRULDs in the EU has been estimated to be between 0.5% and 2% of gross national product (Buckle 1999). In Australia, disorders of the muscles, tendons, and soft tissue (excluding back pain) were estimated to cost AUD519 million or 17% of the total health system costs in 1993 and 1994 (Mathers 1999). In the UK, MSDs were recorded as the second highest reason for sickness certification in 2005, with an average of 22.84 sickness certificates being issued per 1000 person-years (Wynne-Jones 2009). In the US, 52% of the total lost work days were due to MSDs (USBJD 2008), and in Sweden WRULDs constituted 15% of all sick-leave days and 18% of all sickness pensions in 1994 (Buckle 1999). The risk factors for developing WRULDs include individual factors (e.g. inadequate strength, poor posture), physical requirements at the workplace (e.g. work requiring prolonged static posture, highly repetitive work, use of vibrating tools), and organisational and psychosocial factors (e.g. poor work-rest cycle, shift work, low job security, little social support) (Bernard 1997; Buckle 1997; Marras 2009; NIOSH 2001; Shanahan 2006; Yassi 1997).

Description of the intervention

Ergonomics as defined by the International Ergonomics Association is the scientific discipline concerned with the understanding of the interactions among humans and other elements of a system. Ergonomics in the workplace refers to interactions among workers and other elements in the working environment. It is essentially about fitting the job to the worker. Ergonomic design refers to the design of workplace equipment and the work environment; for example by equipment design (e.g. keyboard, mouse, hand tools), workplace design (e.g. workstations, visual display units (VDUs), lighting), and job design (e.g. work pace, work-rest cycle). Ergonomic training includes training in the identification of risk factors for WRULDs, proper work practice, selection of appropriate equipment, correct use of equipment and workstation adjustment. Ergonomic design and training interventions have been heavily promoted for the prevention of WRULDs (NIOSH 1997; NIOSH 2001).

How the intervention might work

Many studies have found that ergonomic factors correlate with musculoskeletal symptoms (Bernard 1994; Bonfiglioli 2006; Ortiz-Hernandez 2003; Szeto 2009; Werner 2005). Adjusting ergonomic factors (such as the design of workplace equipment or the work environment, or both) to reduce the physical and mental load on workers is likely to reduce the risk of workers developing WRULDs. For example, the use of a split keyboard has been found to reduce the severity of pain in computer users with MSDs (Tittiranonda 1999). Ergonomic training is also focused on modifying risk factors through education and empowerment of workers.

Why it is important to do this review

In a systematic review of interventions for the prevention and treatment of WRULDs, Boocock 2007 reviewed papers published between 1999 and 2004. The authors concluded that there was some evidence to support the use of mechanical and modifier interventions for preventing and managing neck/upper extremity musculoskeletal conditions. A further review by Kennedy 2010, which focused on the role of occupational health and safety interventions, found that the use of arm supports reduced upper extremity musculoskeletal diseases (MSDs). However, in addition to randomised controlled trials (RCTs), Boocock 2007 and Kennedy 2010 included other study designs that are at greater risk of bias. Our review extends and updates the search period covered by...
these two reviews and considers all published and unpublished randomised and quasi-randomised trials investigating the use of ergonomic design and training programmes for the prevention of WRULDs.

**OBJECTIVES**

To assess the effects of workplace ergonomic design or training interventions, or both for the prevention of WRULDs in adults.

This review aims to make the following main comparisons:

1. ergonomically designed equipment or environmental interventions versus no or placebo intervention;
2. ergonomically designed equipment or environmental intervention versus another intervention;
3. ergonomic training versus no training or placebo training; and
4. a combination of ergonomically designed equipment and environmental interventions or ergonomic training versus a single intervention or a different combination of interventions.

**METHODS**

**Criteria for considering studies for this review**

**Types of studies**

We included RCTs, quasi-randomised trials (methods of allocating participants to a treatment that are not strictly at random; e.g. by date of birth, hospital record number or alternative), cluster RCTs (i.e. where the unit of randomisation is a group of people such as people working in the same office or shift rather than individual workers) and cross-over trials (i.e. where participants are randomly allocated to a sequence of interventions).

**Types of participants**

We included studies where participants were adults working at the time of the intervention, and who were exposed to risk factors for WRULDs at their workplace. Because the review is focused on prevention of WRULDs, the majority of participants (75% or more) should have been free of WRULDs at the time of the intervention. We only included studies conducted at the workplace or at work-related venues. We excluded studies evaluating treatment interventions for people with established WRULDs (this will be covered in the replacement review to Verhagen 2009), as well as those that focus on rehabilitation of people with acute or chronic conditions (e.g. trauma, neoplasm, and inflammatory or neurological diseases).

**Types of interventions**

We included studies examining at least one ergonomic design or training intervention, or both, at the workplace aimed at the prevention of WRULDs. We excluded studies testing ergonomic design and training for the treatment of individuals diagnosed with WRULDs or for prevention of WRULDs outside the workplace.

**Interventions and specific comparisons**

We categorised interventions as:

- ergonomically designed equipment such as specially designed computer mouse or arm support;
- ergonomically designed work environment (including workplace and job design);
- ergonomic training;
- ergonomic training combined with ergonomic equipment.

**Types of outcome measures**

**Primary outcomes**

1. Number of people with newly diagnosed or verified WRULDs (incident cases).
2. Complaints or symptoms of pain or discomfort in the upper limb or neck, or both, using a dichotomy scale (e.g. yes/no), Likert scale, visual analogue scale (VAS), or any similar scale measuring pain or discomfort.
3. Work-related function as measured by number of work days lost, loss of or change in job, work disability, and level of functioning. For the lattermost, preference was given to validated outcome measures (e.g. Disability of the Arm, Shoulder, and Hand (DASH) questionnaire (Kitsis 2009)). However, all studies that fulfilled the inclusion and exclusion criteria were included in the review regardless of whether the outcome measures used had been validated.

**Secondary outcomes**

Secondary outcomes included change in productivity, costs (including costs of implementation of the intervention and treatment/rehabilitation costs for workers with pain/disability), and compliance (attitude and practice).

**Search methods for identification of studies**

**Electronic searches**
We systematically searched the following databases:
- Cochrane Bone, Joint and Muscle Trauma Group Specialised Register (19 Jul 2010);
- the Cochrane Occupational Safety and Health review group database (19 Jul 2010);
- the Cochrane Central Register of Controlled Trials (The Cochrane Library, 2010 issue 3 (Appendix 1));
- MEDLINE (1950 to Jul Week 1 2010) (Appendix 2);
- EMBASE (1980 to 2010 Week 28) (Appendix 3);
- Science Citation Index (ISI) (Web of Science expanded to 19 Jul 2010) (Appendix 4);
- CINAHL (1982 to 16 Jul 2010) (Appendix 5);
- AMED (1985 to 19 Jul 2010) (Appendix 6);
- SPORTDiscus (1949 to 16 Jul 2010) (Appendix 7);
- Physiotherapy Evidence Database (PEDro) (accessed 15 Nov 2010);
- US Centers for Disease Control and Prevention, the National Institute for Occupational Safety and Health (NIOSH) database (accessed 15 Nov 2010);
- International Clinical Trials Registry Platform (15 Nov 2010);
- Centre Watch (15 Nov 2010);
- Trials Central (15 Nov 2010);
- UK National Research Register (NRR) Archive (15 Nov 2010);
- US Centers for Disease Control and Prevention’s National Institute for Occupational Safety and Health (NIOSH) website (15 Nov 2010).

We searched the following websites for unpublished and ongoing studies:
- World Health Organization International Clinical Trials Registry Platform (15 Nov 2010);
- Centre Watch (15 Nov 2010);
- Trials Central (15 Nov 2010);
- UK National Research Register (NRR) Archive (15 Nov 2010);
- US Centers for Disease Control and Prevention’s National Institute for Occupational Safety and Health (NIOSH) website (15 Nov 2010).

We considered reports of all languages. The searches were based on the MEDLINE search strategy combined with the sensitivity- and precision-maximising version of the Cochrane Highly Sensitive Search Strategy for identifying RCTs (Lefebvre 2009) (see Appendix 2). We modified the search strategy to use in the other databases.

### Searching other resources

We contacted experts in the field to identify theses and unpublished studies. We looked for additional studies by checking the bibliographies of relevant articles.

### Data collection and analysis

#### Selection of studies

Two review authors (VCWH and MRS) obtained and screened abstracts and citations identified by the searches. The review authors retrieved the full-text articles independently to identify any that may describe eligible studies and performed independent study selection. We resolved all disagreements by discussion. Where there was uncertainty, we contacted the corresponding author to ascertain whether a potentially relevant study met the review inclusion criteria.

#### Data extraction and management

Data extraction was performed independently by two review authors (VCWH and DMU), with checks for discrepancies and processing as described in the Cochrane Handbook for Systematic Reviews of Interventions (Higgins 2011). We resolved all discrepancies by consensus. We used a standard data extraction form based on the form recommended by the Cochrane Bone, Joint and Muscle Trauma Group. We performed all statistical analyses using Review Manager 5.1 (RevMan 2011) software.

#### Assessment of risk of bias in included studies

The risk of bias of included studies was independently assessed by two review authors (VCWH and DMU), using The Cochrane Collaboration’s ‘Risk of bias’ tool (Appendix 8) (Higgins 2011). We graded each study for risk of bias in each of the following domains: sequence generation, allocation concealment, blinding of participants and personnel (performance bias), blinding of outcome assessment (detection bias), incomplete outcome data, selective outcome reporting, and ‘other’ such as contamination bias and reliability of instruments. We assessed the risk of bias associated with (a) blinding and (b) completeness of outcomes for self-reported outcomes and objective outcomes separately. We resolved disagreements between authors regarding the risk of bias for domains by consensus.

#### Measures of treatment effect

We plotted the results of each trial as point estimates, meaning risk ratios (RR) for dichotomous outcomes, and means and standard deviations (SD) for continuous outcomes with 95% confidence intervals (CI) for both types of data. When studies reported different outcome measures but measured the same concept, we calculated the standardised mean differences (SMD) with 95% CI. For studies that had outcomes for both right and left upper limb, we only used the outcome for the right upper limb.

#### Unit of analysis issues

We intended to calculate the design effect for studies that employed a cluster-randomised design but that did not make an allowance for the design effect. According to our assessment the three included cluster-randomised trials were not comparable and thus we did not include them in the meta-analyses. We report their results separately in the text.
Dealing with missing data
We dealt with missing data according to the recommendations in the Cochrane Handbook for Systematic Reviews of Interventions (Higgins 2011); we contacted study authors to request missing data. We contacted four authors for clarification and additional data relating to five studies (Bohr 2000; Brisson 1999; Galinsky 2000; Galinsky 2007; McLean 2001) and we were able to use the additional data for three studies (Brisson 1999; Galinsky 2000; Galinsky 2007).

Assessment of heterogeneity
First we assessed whether studies were sufficiently homogeneous to be included in one comparison, based on the similarity of the timing of the outcome measurement (short term: three to eight weeks, intermediate: eight weeks to six months or long-term: six months or longer) and the type of intervention, what the control condition was, and when the outcome was measured. Second, we tested for statistical heterogeneity by means of the \( I^2 \) statistic as presented in the meta-analysis graphs generated by the RevMan software (RevMan 2011). If this test statistic was greater than 50% we considered there to be substantial heterogeneity between studies.

Assessment of reporting biases
We did not assess publication bias as there were no comparisons for which we could include more than five studies.

Data synthesis
Results of studies were pooled if they had a similar type of intervention, control conditions, and outcome. When studies were statistically heterogeneous a random-effects model was used, otherwise a fixed-effect model was used. We pooled study results data with Review Manager 5.1 software (RevMan 2011). We considered the types of intervention evaluating the effectiveness of ergonomic equipment, supplementary breaks or reduced work hours, and ergonomic training to be sufficiently similar to be pooled for comparison. We did not pool data from the studies assessing ergonomic training together with equipment and safe lifting intervention as the interventions were deemed to be too different.

Whether we had sufficient data to combine the results statistically or not, we assessed the overall quality of the evidence for our primary outcomes by an adapted GRADE approach (Furlan 2009) using the GRADE profiler software (GRADE 2008). The quality of the evidence for a specific outcome was based on performance against five domains: limitations of the study design, inconsistency, indirectness (inability to generalise) and imprecision (insufficient or imprecise data) of results and publication bias across all studies that measured that particular outcome. The overall quality of the evidence for each outcome is the result of a combination of the assessments in all domains.

There are four grades of evidence:
- high-quality evidence: there were consistent findings among at least 75% of RCTs with no limitations of the study design, consistent, direct and precise data and no known or suspected publication biases. Further research is unlikely to change either the estimate or our confidence in the results;
- moderate-quality evidence: one of the domains was not met. Further research is likely to have an important impact on our confidence in the estimate of effect and might change the estimate;
- low-quality evidence: two of the domains were not met. Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate;
- very-low-quality evidence: three of the domains were not met. We are very uncertain about the estimate.

Subgroup analysis and investigation of heterogeneity
We intended to perform subgroup analysis based on: type of participant occupation, study setting, participant gender, and rigour of outcome measurement but sufficient data were not available. The \( I^2 \) values calculated by RevMan to quantify statistical heterogeneity between studies ranged from 0% to 86%. However, as the same two studies (Conlon 2008; Rempel 2006) were included in all meta-analyses, we could not explain why they could have statistically very similar results with some outcomes and then also statistically very different results with others.

Sensitivity analysis
We intended to analyse what the influence of studies with a high risk of bias was by re-analysing the data only for studies with a low risk of bias. However this was not possible as only one study was deemed to have a low risk of bias.

R E S U L T S

Description of studies
See: Characteristics of included studies; Characteristics of excluded studies; Characteristics of ongoing studies.

Results of the search
Our search strategy identified 934 potentially relevant references. Two review authors (VCWH and MRS) assessed the titles, keywords, and abstracts of these references, and selected 27 potentially eligible references. We obtained the publication for all these 27 references.
We identified one additional reference (Meijer 2009) by searching the following additional databases: the US Centers for Disease Control and Prevention, the National Institute for Occupational Safety and Health (NIOSH) database, and the International Occupational Safety and Health Information Centre (CIS) database. Our search for unpublished and ongoing studies through the following websites: World Health Organization International Clinical Trials Registry Platform, Centre Watch, Trials Central and UK National Research Register (NRR) Archive identified one ongoing study that we had identified previously (Driessen 2008). The search of the US Centers for Disease Control and Prevention’s National Institute for Occupational Safety and Health (NIOSH) website did not reveal any additional studies.

We checked the reference lists of all articles that we retrieved as full papers in order to identify potentially eligible studies. We identified two additional studies (Faucett 2002; Galinsky 2000) this way. Of the 30 full-text reports identified, we included 15 reports concerning 13 studies. We excluded 14 and one was an ongoing study (Driessen 2008).

Included studies

We included 15 reports on 13 studies. These studies recruited a total of 2397 participants. For further details regarding the study populations and settings see 'Characteristics of included studies'. All of the studies were RCTs, with three of a cluster-randomised (Brisson 1999; von Thiele 2008; Yassi 2001) and two of a crossover design (Galinsky 2000; Galinsky 2007).

Location and settings

Eight studies were conducted in the US (Bohr 2000; Conlon 2008; Galinsky 2000; Galinsky 2007; Garty 2004; Gerr 2005; Greene 2005; Rempel 2006), three studies in Canada (Brisson 1999; McLean 2001; Yassi 2001), and the remaining two studies in Finland (Lintula 2001) and Sweden (von Thiele 2008). Three studies were conducted in data processing or call centres (Galinsky 2000; Galinsky 2007; Rempel 2006), three studies in universities or colleges (Brisson 1999; Gerr 2004; Greene 2005), two studies in the healthcare sector (von Thiele 2008, Yassi 2001), one study in a transportation company (Bohr 2000), one study in an aerospace firm (Conlon 2008), one study among office employees and researchers (Lintula 2001), and two studies involved several sectors (insurance and financial companies, food product producers, government offices, and universities) (Gerr 2005; McLean 2001).

Type of work

Eleven studies were conducted on participants using computers or conducting data processing (Bohr 2000; Brisson 1999; Conlon 2008; Galinsky 2000; Galinsky 2007; Garty 2004; Gerr 2005; Greene 2005; Lintula 2001; McLean 2001; Rempel 2006), and two on participants engaged in healthcare tasks (von Thiele 2008; Yassi 2001).

Type of intervention

Three studies evaluated training interventions alone (Bohr 2000; Brisson 1999; Greene 2005), one study evaluated a combination of training and equipment interventions (Gatty 2004), one study evaluated a safe lifting intervention (Yassi 2001), four studies evaluated equipment interventions alone (Conlon 2008; Gerr 2005; Lintula 2001; Rempel 2006), and four studies evaluated supplementary breaks or reduced work hours (Galinsky 2000; Galinsky 2007; McLean 2001; von Thiele 2008).

Follow-up period

Five studies had a short follow-up period of between three and eight weeks (Galinsky 2000; Galinsky 2007; Greene 2005; Lintula 2001; McLean 2001). One study had an intermediate-term follow-up period of 16 weeks (Gatty 2004), and seven studies had a long-term follow-up period of between six and 12 months (Bohr 2000; Brisson 1999; Conlon 2008; Gerr 2005; Rempel 2006; von Thiele 2008; Yassi 2001).

Outcomes

The incidence of MSDs was measured in three studies (Conlon 2008; Gerr 2005; Rempel 2006) and the prevalence in a further three studies (Brisson 1999; Gatty 2004; Greene 2005). The severity, intensity, discomfort, and strain associated with musculoskeletal conditions were measured in 11 studies (Bohr 2000; Conlon 2008; Galinsky 2000; Galinsky 2007; Garty 2004; Greene 2005; Lintula 2001; McLean 2001; Rempel 2006; von Thiele 2008; Yassi 2001). One study (von Thiele 2008) reported work ability and a further study (Yassi 2001) had measured DASH.

Eight studies assessed compliance (Bohr 2000; Brisson 1999; Galinsky 2000; Garty 2004; Gerr 2005; McLean 2001; Rempel 2006; Yassi 2001) and one study examined the cost of musculoskeletal injuries (Yassi 2001).

Excluded studies

We excluded altogether 14 studies. We excluded nine studies because more than 25% of the participants at baseline reported musculoskeletal symptoms of the upper limb or neck, or both (Cook 2004; Faucett 2002; Fostervold 2006; Haukkia 2008; Ketola 2002; Meijer 2009; Mekhora 2000; Rempel 2007; Veirster 2008). We excluded two studies because they were not RCTs (Aaras 1998; Pillastirini 2007) and a further two studies had no separate outcome data for upper limb or neck, or both, disorders (Earl-Richardson 2006; Faucett 2007). We excluded one study because it only reported on change in risk level for upper extremity cumulative trauma disorders (Melhorn 1996). For further details regarding
Risk of bias in included studies
Overall we found the risk of bias in the included studies to be high. Of the 13 studies, we judged only one study (Rempel 2006) to have a low risk of bias. The results are summarised in the 'Risk of bias' graph, which is an overview of the review authors' judgements about each 'Risk of bias' item presented as percentages across all included studies (Figure 1). Figure 2 shows the 'Risk of bias' summary of each 'Risk of bias' item for each included study.

Figure 1. 'Risk of bias' graph: review authors' judgements about each 'Risk of bias' item presented as percentages across all included studies.
Figure 2. 'Risk of bias' summary: review authors' judgements about each 'Risk of bias item for each included study.

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Allocation

Three studies (Conlon 2008; Gerr 2005; Rempel 2006) reported using a random number table or equivalent for generating a random sequence and were thus judged to have a low risk of bias. None of studies reported using adequate measures for concealing allocation such using sealed opaque envelopes and so we judged all to have an unclear risk of bias.

Blinding

Blinding of the intervention was not performed in most of the interventions as blinding of the use of different equipment, breaks and training are difficult to achieve. Therefore we judged ten studies to have a high risk for performance bias. The remaining three studies assessed work breaks and work hours interventions (Galinsky 2000; Galinsky 2007; McLean 2001). Although complete blinding for breaks was not possible in these studies, the use of a strict protocol for taking breaks by the use of either custom-made electrical timers or the 'Ergobreak' computer program minimised the risk for bias. Thereby we judged these three studies to have a low risk for performance bias.

In three studies (Brisson 1999; Conlon 2008; Rempel 2006) the physical examination for the detection of MSD was blinded although the examination was only performed on participants that reported symptoms (which were self-reported) meeting the case definition. Thus, we rated the risk for detection bias for all 13 studies as high.

Incomplete outcome data

Three studies conducted an intention-to-treat (ITT) analysis (Conlon 2008; Gerr 2005; Rempel 2006), one study had no loss to follow-up (Lintula 2001) and one study had a low drop-out rate (Brisson 1999). We rated these five studies as having a low risk for attrition bias. We rated six studies (Bohr 2000; Galinsky 2000; Galinsky 2007; Gatty 2004; von Thiele 2008; Yassi 2001) as having a high risk as they did not conduct ITT analyses. In addition, two of these six studies had an uneven drop-out rate across the groups (Bohr 2000; Yassi 2001), two studies had an uneven distribution of participants in experimental groups (von Thiele 2008; Yassi 2001), and three studies had a high drop-out rate (Galinsky 2000; Galinsky 2007; Gatty 2004). We rated two studies as having an unclear risk for attrition bias as they did not conduct ITT analyses and information on their drop-outs was limited (Greene 2005; McLean 2001).

Selective reporting

We judged all studies to be free of selective reporting because they reported all outcomes described in the methods.

Other potential sources of bias

We judged nine studies to have a high risk of bias from other potential sources (Bohr 2000; Brisson 1999; Conlon 2008; Galinsky 2007; Gatty 2004; Gerr 2005; Lintula 2001; McLean 2001; Yassi 2001). According to our assessment, two studies were judged to have a low risk of bias (Galinsky 2000; Rempel 2006) and another two studies to have an unclear risk of bias (Greene 2005; von Thiele 2008).

In five studies, baseline data on the outcome measures were not available (Bohr 2000; Brisson 1999; Lintula 2001; McLean 2001; Yassi 2001) for comparison. In the Gatty 2004 study, the intervention group had lower average wrist-hand and upper back ache or pain intensity compared to the control group. In the Conlon 2008 study the participants who volunteered for the study had higher levels of discomfort than non-participants. In the Bohr 2000 study, the close proximity of the workstations may have led to cross contamination of the intervention effect. In the Gerr 2005 study, there was large number of drop-outs in the intervention and control groups, although the authors have conducted ITT analysis, the large number of drop-outs may affect the results.

Six studies (Galinsky 2000; Galinsky 2007; Gatty 2004; Greene 2005; McLean 2001; Rempel 2006) did not compare the differences between the participants and non-participants, which has the potential to jeopardise the external validity of the results. In one cluster-RCT, differences between the workplaces may have influenced the intervention (von Thiele 2008).

Of the two cross-over RCTs (Galinsky 2000; Galinsky 2007), Galinsky 2007 had the potential for carry-over effect (Hawthorne effects). The authors did not report on the wash-out period between the two data collection periods.

Effects of interventions

See: Summary of findings for the main comparison Comparing arm support with alternative mouse versus conventional mouse alone for preventing work-related musculoskeletal disorders of the upper limb and neck in adults; Summary of findings 2 Comparing alternative mouse alone versus conventional mouse alone for preventing work-related musculoskeletal disorders of the upper limb and neck in adults; Summary of findings 3 Comparing arm support with conventional mouse versus conventional mouse alone for preventing work-related musculoskeletal disorders of the upper limb and neck in adults; Summary of findings 4 Comparing alternative mouse with arm support versus conventional mouse with arm support for preventing work-related musculoskeletal disorders of the upper limb and neck in adults; Summary of findings 5 Comparing supplementary breaks versus conventional breaks for preventing work-related musculoskeletal disorders of the upper limb and neck.
in adults
The 13 included studies evaluated several ergonomic interventions for preventing WRULDs. They included ergonomic training alone, ergonomic training and equipment, ergonomic equipment alone, and supplementary breaks or reduced work hours.

I. Studies evaluating the effectiveness of ergonomic equipment

Primary outcome
Four studies (Conlon 2008; Gerr 2005; Lintula 2001; Rempel 2006) evaluated the effectiveness of interventions involving ergonomic equipment. All the studies were conducted among computer users.

Two studies (Conlon 2008; Rempel 2006) evaluated four different interventions. These studies compared conventional mouse alone (without arm support), alternative mouse alone (without arm support), conventional mouse with arm support, and alternative mouse with arm support. One study (Gerr 2005) evaluated three different interventions; that is two different monitor, mouse and keyboard placements with arm rest and high-quality chair intervention, and no intervention. Another study (Lintula 2001) evaluated arm support for the hand that operated the mouse, arm support for both hands, and no arm support. According to our judgement, only the studies by Conlon 2008 and Rempel 2006 were comparable and also their data were available for meta-analysis. Although the study by Lintula 2001 also evaluated an arm support, the duration of the study was only for six weeks, whereas the duration of the studies by Conlon 2008 and Rempel 2006 were 12 months. Lintula 2001 only assessed perceived musculoskeletal strain and did not assess MSDs or symptoms.

Gerr 2005 evaluated the difference of two different placements of the monitor, keyboard, mouse, arm rest and chair (intervention groups A and B) compared with no intervention (control group C). There were no differences in time to symptoms between intervention group A or group B when compared to control group C for either hand or arm symptoms (group A vs C: hazard ratio (HR) 0.92; 95% CI 0.49 to 1.71; group B vs C: HR 1.05; 95% CI 0.58 to 1.90), or neck or shoulder symptoms (group A vs C: HR 1.07; 95% CI 0.64 to 1.80; group B vs C: HR 1.00; 95% CI 0.60 to 1.68).

Data from the Conlon 2008 and Rempel 2006 studies were included in meta-analysis.

a. An arm support together with an alternative mouse versus a conventional mouse alone
Using an arm support together with an alternative mouse compared to using a conventional mouse alone decreased the incidence of neck/shoulder disorders (RR 0.73; 95% CI 0.32 to 1.66; Analysis 1.1). However, there was no difference in the incidence of right upper limb (RR 0.73; 95% CI 0.32 to 1.66; Analysis 1.2) or upper body disorders (RR 0.66; 95% CI 0.42 to 1.04; Analysis 1.3) when these interventions were compared. The use of an arm support together with an alternative mouse also decreased neck/shoulder discomfort scores (SMD -0.41; 95% CI -0.69 to -0.12; Analysis 1.4) and right upper limb discomfort scores (SMD -0.34; 95% CI -0.63 to -0.06; Analysis 1.5) when compared to using a conventional mouse alone.

b. An alternative mouse alone versus a conventional mouse alone
The results comparing alternative mouse alone and conventional mouse alone showed that there was no difference in the incidence of disorders of the neck/shoulder (RR 0.62; 95% CI 0.19 to 2.00; Analysis 2.1), right upper limb (RR 0.91; 95% CI 0.48 to 1.72; Analysis 2.2), or upper body (RR 0.79; 95% CI 0.52 to 1.21; Analysis 2.3), and no difference in discomfort scores for neck/shoulder (SMD 0.04; 95% CI -0.26 to 0.33; Analysis 2.4) or right upper limb (SMD 0.00; 95% CI -0.28 to 0.28; Analysis 2.5).

c. An arm support together with a conventional mouse versus a conventional mouse alone
The results comparing arm support with conventional mouse and conventional mouse alone showed that there was no difference in the incidence of disorders of the neck/shoulder (RR 0.67; 95% CI 0.36 to 1.24; Analysis 3.1), right upper limb (RR 1.09; 95% CI 0.51 to 2.29; Analysis 3.2), or upper body (RR 0.87; 95% CI 0.42 to 1.80; Analysis 3.3), and no difference in discomfort scores for neck/shoulder (SMD 0.02; 95% CI -0.26 to 0.30; Analysis 3.4) or right upper limb (SMD -0.07; 95% CI -0.35 to 0.22; Analysis 3.5).

d. An alternative mouse with an arm support versus a conventional mouse with an arm support
The results comparing alternative mouse with arm support and conventional mouse with arm support showed no difference in the incidence of disorders of the neck/shoulder (RR 0.76; 95% CI 0.22 to 2.63; Analysis 4.1), right upper limb (RR 0.76; 95% CI 0.37 to 1.59; Analysis 4.2), or upper body (RR 0.77; 95% CI 0.36 to 1.63; Analysis 4.3). The results did show a decrease in the discomfort scores for the neck/shoulder (SMD -0.39; 95% CI -0.67 to -0.10; Analysis 4.4) and also a non-significant decrease in the right upper extremity (SMD -0.27; 95% CI -0.55 to 0.02; Analysis 4.5).

Secondary outcome
In the Gerr 2005 study, compliance with all components of the intervention was attained for only 25% to 38% of participants.
mainly because of the inflexibility of the workstation configurations. Rempel 2006 found that there were no significant differences between intervention groups for company-tracked productivity or self-perceived measures.

Quality of evidence
There was moderate-quality evidence from two studies to support using an arm support together with an alternative mouse to prevent neck/shoulder disorders over a 12-month follow-up but not disorders of the upper body or right upper extremity (Conlon 2008; Rempel 2006). There was also low-quality evidence from the same two studies that the intervention reduced the discomfort score for neck/shoulder and right upper extremity over a 12-month follow-up. There was moderate-quality evidence from one study that different VDU placement produced no difference in neck, shoulder, or arm and hand symptoms over a six-month follow-up (Gerr 2005).

2. Studies evaluating the effectiveness of supplementary breaks or reduced work hours

Primary outcome
Four studies (Galinsky 2000; Galinsky 2007; McLean 2001; von Thiele 2008) evaluated the effectiveness of supplementary breaks or reduced work hours. Three studies (Galinsky 2000; Galinsky 2007; McLean 2001) evaluated supplementary breaks among computer users or data entry operators over a period ranging between four and eight weeks and one study (von Thiele 2008) evaluated reduced work hours in a large public healthcare organisation over 12 months. The von Thiele 2008 study compared physical exercise and reduced work hours to a reference group (normal work hours). We used only the results comparing reduced work hours and normal work hours for this review. We included data from the Galinsky 2000 and Galinsky 2007 studies in a meta-analysis. We could not enter the data from the McLean 2001 study into a meta-analysis as the authors reported no measure of variance and this data could not be imputed from the information provided.

a. Supplementary breaks versus conventional breaks
The results comparing supplementary versus conventional breaks showed that there were no differences in the end of the shift discomfort scores for the neck (MD -0.25; 95% CI -0.53 to 0.02; Analysis 5.1), right shoulder/upper arm (MD -0.24; 95% CI -0.51 to 0.03; Analysis 5.2), and right forearm/wrist/hand (MD -0.19; 95% CI -0.45 to 0.08; Analysis 5.3) (Galinsky 2000; Galinsky 2007).

b. Reduced work hours versus normal work hours
The results comparing reduced work hours (37.5 hours/week) and normal work hours (40 hours/week) showed that there was no difference between the reduced and normal work hours groups in upper-extremity symptoms or pain at six months (MD 0.08; 95% CI -0.32 to 0.48; Analysis 6.1) or at 12 months (MD 0.22; 95% CI -0.22 to 0.66; Analysis 6.2) (von Thiele 2008). There was equally no difference between the reduced and normal work hours groups in work ability at six months (MD 0.41; 95% CI 0.28 to 1.10; Analysis 6.3) or at 12 months (MD 0.50; 95% CI 0.23 to 1.23; Analysis 6.4) (von Thiele 2008).

Secondary outcome
Galinsky 2000 found no significant difference between the two groups in productivity as measured by the mean number of keystrokes per hour and mean number of documents entered. McLean 2001 also found that no difference between the groups in productivity measured as number of words typed.

Quality of evidence
There was low-quality evidence from two studies that breaks produced no difference in neck, right shoulder/upper arm, or forearm/wrist/hand discomfort ratings at end of shift (Galinsky 2000; Galinsky 2007). There was low-quality evidence from one study that a reduced work hour intervention produced no difference in upper-extremity disorders or work ability (von Thiele 2008).

3. Studies evaluating the effectiveness of ergonomic training

Primary outcome: ergonomic training versus no intervention
Three studies evaluated the effect of ergonomic training. These studies compared a participatory education intervention versus traditional education versus no intervention (Bohr 2000); PRECEDE (predisposing, reinforcing and enabling causes in educational diagnosis evaluation) ergonomic training versus no intervention (Brisson 1999); and active ergonomic training versus no intervention (control) (Greene 2005). Greene 2005 only conducted the first three weeks as an RCT, with the control group given the same intervention after the third week (see Characteristics of included studies).

In the participatory education, PRECEDE ergonomic training, and active ergonomic training interventions, the intervention consists of the participants solving ergonomic issues at the workplace. All three studies were conducted on computer users who used computers at least five hours per week. We could not combine the studies’ results data for meta-analysis as Bohr 2000 reported on upper body discomfort scores; Brisson 1999 reported on prevalence...
of neck-shoulder pain and hand-wrist pain; and Greene 2005 only performed a follow-up for three weeks on the intensity, frequency, and duration of pain in the upper spine (head, neck, and upper back) and upper extremity (shoulder/upper arm, elbow/forearm, wrist and hand). Bohr 2000 also did not report a measure of variance and it could not be imputed from the information provided. The results for Brisson 1999 showed that over a six-month period there was no difference in the risk for neck-shoulder symptoms (RR 1.19; 95% CI 0.66 to 2.14; Analysis 7.1) or hand-wrist symptoms (RR 1.39; 95% CI 0.41 to 4.74; Analysis 7.2). Greene 2005 showed that there was no significant difference in the intensity (MD 0.08; 95% CI -0.22 to 0.38; Analysis 7.3), frequency (MD -0.03; 95% CI -0.45 to 0.39; Analysis 7.4), or duration (MD 0.13; 95% CI -0.25 to 0.51; Analysis 7.5) of upper extremity symptoms between the intervention and control group at the end of the third week.

Secondary outcome
Of these three studies, Bohr 2000 and Brisson 1999 assessed the compliance of the participants to the intervention. Bohr 2000 found no significant differences across groups for work area configuration, worker postures, or overall observation scores. Brisson 1999 found that the compliance to the intervention in the under 40 years of age group was higher than that for subjects over 40 years of age.

Quality of evidence
There was very-low-quality evidence from two studies that an ergonomic training intervention produced no difference in neck and upper extremity symptoms (Brisson 1999; Greene 2005).

4. Studies evaluating the effectiveness of ergonomic training and equipment

Primary outcome
One study (Gatty 2004) evaluated the combined effect of ergonomic training and equipment interventions. The study was conducted on clerical and office workers, and evaluated the effectiveness of a work injury prevention programme that included education, workstation redesign, and task modification compared to no intervention. Only the first 16 weeks of the study was performed as an RCT.

The results showed no significant difference in frequency of neck (MD -1.20; 95% CI -2.77 to 0.37; Analysis 8.1), shoulder (MD -1.10; 95% CI -2.65 to 0.45; Analysis 8.2), or wrist/hand ache or pain (MD -1.00; 95% CI -2.52 to 0.52; Analysis 8.3) at the end of 16 weeks comparing intervention versus no intervention. The result also showed no significant difference in the intensity of neck (MD -0.30; 95% CI -1.19 to 0.59; Analysis 8.4), shoulder (MD -0.20; 95% CI -0.91 to 0.51; Analysis 8.5), or wrist/hand ache or pain (MD -0.20; 95% CI -1.17 to 0.77; Analysis 8.6) at the end of 16 weeks comparing intervention versus no intervention. We could not estimate the results comparing the frequency and intensity of elbow or forearm ache or pain at the end of 16 weeks as the SD for the intervention groups were zero for both readings.

Secondary outcome
Gatty 2004 assessed the participants’ compliance to the intervention. Self-reported compliance in the intervention group was high at the end of the study, with the greatest level of compliance obtained for ergonomic equipment.

Quality of evidence
There was very-low-quality evidence from one study that a work injury prevention programme yielded no difference in neck and upper-extremity symptoms among office workers (Gatty 2004).

5. Studies evaluating the effectiveness of lifting interventions

Primary outcome
One study (Yassi 2001) evaluated the effect of a lifting intervention to prevent patient lift and transfer injuries in healthcare workers. The study was conducted among nurses and unit assistants in medical, surgical, and rehabilitation wards. The study compared a no strenuous lifting programme and training versus a safe lifting programme and training versus usual practice for lifting patients in the wards.

The Yassi 2001 results at the end of one year showed no significant difference in the shoulder symptoms score comparing safe lifting with usual practice (MD 3.00; 95% CI -4.83 to 10.83; Analysis 9.1), and no strenuous lifting compared with usual practice (MD 0.10; 95% CI -7.62 to 7.82; Analysis 9.2). There was also no significant difference in the DASH score between safe lifting and usual practice (MD 1.00; 95% CI -2.32 to 4.32; Analysis 9.3) and between no strenuous lifting and usual practice (MD -0.80; 95% CI -3.75 to 2.15; Analysis 9.4).

Secondary outcome
Yassi 2001 also assessed the participants’ compliance to the intervention, cost of all injuries, and time loss injuries. The authors noted a marked increase in the use of both mechanical and non-mechanical equipment six months into the study and a marked decline in patient handling without assistive devices in both the intervention groups. The authors noted that the cost of all injuries was highest for the control group (USD23,984), followed by the safe lifting (USD20,179), and no strenuous lifting (USD13,502).
groups. The cost for time loss injuries was highest for the control
group (USD3426), followed by no strenuous lifting (USD3376),
and safe lifting (USD2522) groups.

Quality of evidence
There was low-quality evidence from one study showing that a
patient lifting intervention produced no difference in shoulder
symptoms among nursing personnel (Yassi 2001).
### Patient or population:
patients with work-related musculoskeletal disorders of the upper limb and neck in adults

### Settings:
VDU users (> 20 hours per week)

### Intervention:
alternative mouse alone (no arm support)

### Comparison:
conventional mouse alone (no arm support)

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Illustrative comparative risks* (95% CI)</th>
<th>Relative effect (95% CI)</th>
<th>No of participants (studies)</th>
<th>Quality of the evidence (GRADE)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assumed risk</td>
<td>Corresponding risk</td>
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<td></td>
</tr>
<tr>
<td>Incidence of upper body disorder (neck, shoulder, and upper extremity)</td>
<td>Study population</td>
<td>RR 0.79 (0.52 to 1.21)</td>
<td>190 (2 studies)</td>
<td>⊕⊕⊕ moderate</td>
<td>Moderate</td>
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<tr>
<td></td>
<td>Incidence of neck/shoulder disorder</td>
<td>Questionnaire followed by medical examination</td>
<td>RR 0.62 (0.19 to 2)</td>
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<td>Quality of the evidence</td>
<td>Comments</td>
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<td>(studies)</td>
<td>(GRADE)</td>
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<td></td>
<td>(0.48 to 1.72)</td>
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<td>185 per 1000</td>
<td>168 per 1000</td>
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<td>(89 to 318)</td>
<td>(2 studies)</td>
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<tr>
<td>Moderate</td>
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<tr>
<td>184 per 1000</td>
<td>167 per 1000</td>
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<tr>
<td>(88 to 316)</td>
<td>(2 studies)</td>
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### Right upper extremity discomfort score

<table>
<thead>
<tr>
<th>Study population</th>
<th>SMD 0 (-0.28 to 0.28)</th>
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<tbody>
<tr>
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<td></td>
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<tr>
<td>195</td>
<td>(2 studies)</td>
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<td>(2 studies)</td>
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</table>

### Neck/shoulder discomfort score

<table>
<thead>
<tr>
<th>Study population</th>
<th>SMD 0.04 (-0.26 to 0.33)</th>
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<td></td>
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<td>195</td>
<td>(2 studies)</td>
</tr>
<tr>
<td>(2 studies)</td>
<td></td>
</tr>
</tbody>
</table>

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*The basis for the assumed risk (e.g. the median control group risk across studies) is provided in footnotes. The corresponding risk (and its 95% CI) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).

CI: confidence interval; RR: risk ratio; VDU: visual display unit.

GRADE Working Group grades of evidence

**High quality:** Further research is very unlikely to change our confidence in the estimate of effect.

**Moderate quality:** Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.

**Low quality:** Further research is very likely to have an important impact on our confidence in the estimate of effect.

**Very low quality:** We are very uncertain about the estimate.
1 Total number of participants <300 (small sample size for categorical variable)
2 Measure of outcome based on subjective symptoms (detection bias)
**Patient or population:** patients with work-related musculoskeletal disorders of the upper limb and neck in adults  
**Settings:** VDU users (> 20 hours per week)  
**Intervention:** arm support board (with conventional mouse)  
**Comparison:** no arm support board (with conventional mouse)

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Illustrative comparative risks* (95% CI)</th>
<th>Relative effect (95% CI)</th>
<th>No of participants (studies)</th>
<th>Quality of the evidence (GRADE)</th>
<th>Comments</th>
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<tr>
<td><strong>Incidence of upper body disorders</strong></td>
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<tr>
<td>Conventional mouse</td>
<td>Arm support with conventional mouse</td>
<td>Study population</td>
<td></td>
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<td></td>
<td></td>
<td>Questionnaire followed by medical examination</td>
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<td></td>
<td></td>
<td>Follow-up: 12 months</td>
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<tr>
<td></td>
<td></td>
<td>333 per 1000 (140 to 600)</td>
<td>RR 0.87 (0.42 to 1.8)</td>
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<td>344 per 1000 (144 to 619)</td>
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<td><strong>Incidence of neck/shoulder disorder</strong></td>
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<tr>
<td>Conventional mouse</td>
<td>Arm support with conventional mouse</td>
<td>Study population</td>
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<td>Questionnaire followed by medical examination</td>
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<td>Follow-up: 12 months</td>
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<td></td>
<td>232 per 1000 (83 to 287)</td>
<td>RR 0.67 (0.36 to 1.24)</td>
<td>186 (2 studies)</td>
<td>⊕⊕⊕ moderate ¹</td>
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<td>250 per 1000 (90 to 310)</td>
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<td><strong>Incidence of right upper extremity disorders</strong></td>
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<tr>
<td>Conventional mouse</td>
<td>Arm support with conventional mouse</td>
<td>Study population</td>
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<td>Questionnaire followed by medical examination</td>
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<td>OR 1.09 (0.51 to 2.29)</td>
<td>178 (2 studies)</td>
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<td>Follow-up: 12 months</td>
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<td>198 per 1000</td>
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<td></td>
<td>(104 to 342)</td>
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<tr>
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<td>197 per 1000</td>
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<tr>
<td></td>
<td>(103 to 341)</td>
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</table>

| Neck/shoulder discomfort score | The mean neck/shoulder discomfort score in the intervention groups was 0.02 standard deviations higher (0.26 lower to 0.3 higher) | 195 (2 studies) | low | SMD 0.02 (-0.26 to 0.3) |

| Right upper extremity discomfort score | The mean right upper extremity discomfort score in the intervention groups was 0.07 standard deviations lower (0.35 lower to 0.22 higher) | 195 (2 studies) | low | SMD -0.07 (-0.35 to 0.22) |

*The basis for the assumed risk (e.g. the median control group risk across studies) is provided in footnotes. The corresponding risk (and its 95% CI) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).

CI: confidence interval; OR: odds ratio; RR: risk ratio; VDU: visual display unit

GRADE Working Group grades of evidence

**High quality:** Further research is very unlikely to change our confidence in the estimate of effect.

**Moderate quality:** Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.

**Low quality:** Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.

**Very low quality:** We are very uncertain about the estimate.

1. Total number of participants <300 (small sample size for categorical variable)
<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Illustrative comparative risks* (95% CI)</th>
<th>Relative effect (95% CI)</th>
<th>No of participants (studies)</th>
<th>Quality of the evidence (GRADE)</th>
<th>Comments</th>
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<tr>
<td><strong>Assumed risk</strong></td>
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<tr>
<td>Conventional mouse with arm support</td>
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<tr>
<td>Alternative mouse with arm support</td>
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<tr>
<td><strong>Incidence of upper body symptoms</strong></td>
<td></td>
<td>RR 0.77 (0.36 to 1.63)</td>
<td>190 (2 studies)</td>
<td>☠️⊕⊕⊕ moderate</td>
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<tr>
<td>Study population</td>
<td>Questionnaire followed by medical examination</td>
<td>284 per 1000 (102 to 463)</td>
<td>219 per 1000 (103 to 465)</td>
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<td>Follow-up: 12 months</td>
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<tr>
<td><strong>Incidence of neck/shoulder disorder</strong></td>
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<td>RR 0.58 (0.3 to 1.12)</td>
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<td>☠️⊕⊕⊕ moderate</td>
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<td>Study population</td>
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<td>221 per 1000 (66 to 248)</td>
<td>128 per 1000 (68 to 253)</td>
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### Incidence of right upper extremity disorders

<table>
<thead>
<tr>
<th>Study population</th>
<th>RR 0.92</th>
<th>175</th>
<th>moderate</th>
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<tbody>
<tr>
<td>163 per 1000</td>
<td>(0.36 to 2.36)</td>
<td>(2 studies)</td>
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<tr>
<td>150 per 1000</td>
<td>(59 to 384)</td>
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</tbody>
</table>

**Follow-up: 12 months**

**Study population**
- **RR 0.92**: (0.36 to 2.36)
- **175**: (2 studies)
- **moderate**

### Neck/shoulder discomfort score

<table>
<thead>
<tr>
<th>Study population</th>
<th>SMD -0.39 (-0.67 to -0.1)</th>
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<tbody>
<tr>
<td>169 per 1000</td>
<td>193</td>
</tr>
<tr>
<td>155 per 1000</td>
<td>(61 to 399)</td>
</tr>
</tbody>
</table>

**Follow-up: 12 months**

- **The mean neck/shoulder discomfort score in the intervention groups was 0.39 standard deviations lower (0.67 to 0.1 lower)**
- **SMD -0.39 (-0.67 to -0.1)**
- **low**

### Right upper extremity discomfort score

<table>
<thead>
<tr>
<th>Study population</th>
<th>SMD -0.27 (-0.55 to 0.02)</th>
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</thead>
<tbody>
<tr>
<td>169 per 1000</td>
<td>193</td>
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<tr>
<td>155 per 1000</td>
<td>(61 to 399)</td>
</tr>
</tbody>
</table>

**Follow-up: 12 months**

- **The mean right upper extremity discomfort score in the intervention groups was 0.27 standard deviations lower (0.55 lower to 0.02 higher)**
- **SMD -0.27 (-0.55 to 0.02)**
- **low**

### Notes
- *The basis for the assumed risk (e.g. the median control group risk across studies) is provided in footnotes. The corresponding risk (and its 95% CI) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).*
- CI: confidence interval; RR: risk ratio; VDU: visual display unit.

### GRADE Working Group grades of evidence

- **High quality**: Further research is very unlikely to change our confidence in the estimate of effect.
- **Moderate quality**: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
- **Low quality**: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
- **Very low quality**: We are very uncertain about the estimate.

1 **Total number of participants <300 (small sample size for categorical variable)**
Measure of outcome was based on subjective symptoms (detection bias).
Patient or population: patients with work-related musculoskeletal disorders of the upper limb and neck in adults
Settings: VDU users
Intervention: supplementary breaks
Comparison: conventional breaks

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Illustrative comparative risks* (95% CI)</th>
<th>Relative effect (95% CI)</th>
<th>No of participants (studies)</th>
<th>Quality of the evidence (GRADE)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assumed risk Corresponding risk</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Conventional breaks Supplementary breaks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discomfort ratings for neck (all time) (4-8 weeks) Questionnaire Follow-up: 4-8 weeks</td>
<td>The mean discomfort ratings for neck (all time) (4-8 weeks) in the intervention groups was <strong>0.17 lower</strong> (0.39 lower to 0.06 higher)</td>
<td>186 (2 studies)</td>
<td>⊕⊕ ⋄ ⋄ ⋄ low¹ ² ³ ⁴</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discomfort ratings of the right shoulder/upper arm (all time) (4-8 weeks) Questionnaire Follow-up: 4-8 weeks</td>
<td>The mean discomfort ratings of the right shoulder/upper arm (all time) (4-8 weeks) in the intervention groups was <strong>0.13 lower</strong> (0.35 lower to 0.08 higher)</td>
<td>186 (1 study)</td>
<td>⊕⊕ ⋄ ⋄ ⋄ low¹ ² ³ ⁴</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discomfort ratings of right forearm/wrist/hand (all time) (4-8 weeks) Questionnaire Follow-up: 4-8 weeks</td>
<td>The mean discomfort ratings of right forearm/wrist/hand (all time) (4-8 weeks) in the intervention groups was <strong>0.12 lower</strong> (0.34 lower to 0.09 higher)</td>
<td>186 (2 studies)</td>
<td>⊕⊕ ⋄ ⋄ ⋄ low¹ ² ³ ⁴</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### After shifts discomfort rating for neck (4-8 weeks)

| Questionnaire | Follow-up: 4-8 weeks | The mean after shifts discomfort rating for neck (4-8 weeks) in the intervention groups was **0.25 lower** (0.53 lower to 0.02 higher) | 186 (2 studies) | ⊕⊕⊕ low1,2,3,4 |

### After shifts discomfort ratings for right shoulder/upper arm (4-8 weeks)

| Questionnaire | Follow-up: 4-8 weeks | The mean after shifts discomfort ratings for right shoulder/upper arm (4-8 weeks) in the intervention groups was **0.24 lower** (0.51 lower to 0.03 higher) | 186 (2 studies) | ⊕⊕ low1,2,3,4 |

### After shifts discomfort ratings for right forearm/wrist/hand (4-8 weeks)

| Questionnaire | Follow-up: 4-8 weeks | The mean after shifts discomfort ratings for right forearm/wrist/hand (4-8 weeks) in the intervention groups was **0.19 lower** (0.45 lower to 0.08 higher) | 186 (2 studies) | ⊕⊕ low1,2,3,4 |

*The basis for the assumed risk (e.g. the median control group risk across studies) is provided in footnotes. The corresponding risk (and its 95% CI) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).

CI: confidence interval; VDU: visual display unit.

GRADE Working Group grades of evidence

**High quality:** Further research is very unlikely to change our confidence in the estimate of effect.

**Moderate quality:** Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.

**Low quality:** Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.

**Very low quality:** We are very uncertain about the estimate.
1. Possibility of cross-over effects of cross-over trials
2. Measured of outcome was based on subjective symptoms (detection bias)
3. There was no information on sequence generation (selection bias)
4. Small number of participants (<400)
DISCUSSION
The objective of this review was to assess the effects of workplace ergonomic interventions for the prevention of WRULDs in adults.

Summary of main results
This systematic review identified 13 RCTs of workplace ergonomic design and training interventions for the prevention of WRULDs in adults. We found that the use of an arm support with alternative mouse for VDU users reduced the symptoms of upper limb and neck discomfort and incidence of neck or shoulder disorders. However, there was no difference in the incidence of right upper limb and upper body disorders. This single positive result could be a chance finding as we performed multiple comparisons comparing four different interventions and three different outcomes. Using an alternative mouse alone or an arm support alone did not demonstrate any benefit when compared to using a conventional mouse alone. There was moderate- to low-quality evidence to support this (Conlon 2008; Rempel 2006).

There was low-quality evidence that supplementary breaks were not effective in reducing discomfort of the neck, right shoulder, or upper limb or right forearm or wrist or hand (Galinsky 2000; Galinsky 2007). There was very-low- to moderate-quality evidence that other ergonomics interventions were not effective in preventing WRULDs (Bohr 2000; Brissone 1999; Gatty 2004; Gerr 2005; Greene 2005; Lintula 2001; von Thiele 2008; Yassi 2001).

Overall completeness and applicability of evidence
We consider that the studies included in this review form the best available evidence for the review question. We have conducted an extensive search of the literature in all relevant medical databases and we have included 13 studies on workplace interventions for preventing MSDs of the upper limb and neck in adults. Not all studies reported on the outcomes that were relevant to this review and some of the studies presented results in a way that could not be used for meta-analysis. The review found that there is moderate evidence for the use of an arm support together with an alternative mouse for reducing the symptoms of upper limb and neck discomfort and incidence of neck or shoulder disorders among VDU users. Using an alternative mouse alone or an arm support alone did not demonstrate any benefit when compared to using a conventional mouse alone. The alternative mouse designs that were used in these studies were a mouse with a neutral forearm posture (Conlon 2008) and a track ball (Rempel 2006). However, given there were multiple comparisons made involving a number of interventions and outcomes, high-quality evidence is needed to determine the effectiveness of these interventions clearly.

There was low- to moderate-quality evidence that the other interventions investigated in this review did not demonstrate any benefit in terms of preventing work-related MSDs of the right upper limb and neck. The reason for the absence of benefit may be because of lack of statistical power to detect relevant changes. The interventions on supplementary breaks demonstrated a reduction in discomfort scores but the results were not statistically significant. This may have been because of the inadequate sample size of these studies. We were unable to pool more studies in meta-analyses - which would have increased power - because the workplace, outcome measures, or type or duration of interventions were not comparable.

Quality of the evidence
We included a total of 13 studies in this review, including five different types of interventions each containing several subtypes of intervention. As a result, each subtype of intervention was only assessed in between one and three studies and we performed meta-analyses only on subtypes containing two or more studies that had comparable outcomes. We assessed the quality of evidence for each subtype regardless of whether it was included in meta-analyses. We assessed the quality of evidence per outcome using the GRADE profiler software (GRADE 2008).

There was moderate- to low-quality evidence on the effectiveness of ergonomic equipment interventions and low- to very-low-quality evidence on the effectiveness of supplementary breaks or reduced work hours, ergonomic training, and ergonomic training offered together with equipment. The quality of evidence was downgraded owing to small sample size, lack of information on ITT, use of subjective outcome measures (detection bias), lack of information on sequence generation (selection bias), and lack of information on allocation concealment (selection bias). The main quality concerns were small sample sizes and use of subjective outcome measures (detection bias), which occurred for all the interventions. Although all the studies were RCTs, the majority of the studies did not report the methods for random sequence generation and allocation concealment. This has led us to the downgrade the quality of evidence because of the possibility of selection bias. Future studies should use random sequence generation and adequate allocation concealment and provide a clear description of how each was achieved to minimise selection bias.

Potential biases in the review process
We have conducted a comprehensive and transparent review. We conducted the entire process of study selection, data extraction, and assessment of risk of bias of included studies was independently by two review authors and we resolved any disagreements through consensus. We minimised selection bias in our search by
screening references of identified trials and systematic reviews, by contacting experts in the research field, and by not restricting our search strategy by language or publication date. Even though our search strategy was comprehensive, there is always a risk that relevant studies may not have been identified in the review process. We were unable to assess the risk of publication bias adequately as there were limited studies assessing similar interventions and outcomes. We avoided duplicate publication bias by using study data only once. In our included studies, there were two studies that were each reported twice. We combined the results from the two reports and only used the data that were appropriate for this review. We were able to obtain missing data for three studies.

This review included only RCTs since methodologically weaker designs can easily lead to bias. In the field of occupational health, randomisation is sometimes difficult to perform. From the ‘Risk of bias’ tables it can be noted that there were high number of studies with a classification of unclear in the sequence generation and allocation concealment domains. This implies that the primary publication does not supply enough information to assess bias. We did not seek further information from the authors for the course of simplicity and resources. Instead, we chose to complete the ‘Risk of bias’ assessment solely based on information provided in the published reports.

We only included studies where 75% or more of the participants were free of WRULDs at baseline. Nine studies were excluded because more than 25% of the participants at baseline reported musculoskeletal symptoms of the upper limb or neck, or both (Cook 2004; Faucett 2002; Fostervold 2006; Haukka 2008; Ketola 2002; Meijer 2009; Mekhora 2000; Rempel 2007; Veiersted 2008). The strict criteria used are likely to have reduced the number of studies included in this review.

Agreements and disagreements with other studies or reviews

The results of this review differ from two earlier systematic reviews by Boocock 2007 and Kennedy 2010. Our review focused on prevention of MSDs and excluded studies where 25% or more of the participants had MSDs of the upper limb or neck. What is more, Boocock 2007 and Kennedy 2010 classified interventions differently and included also study designs other than RCTs. Because of their lesser inclusion criteria, Boocock 2007 included 31 studies and Kennedy 2010 included 36 studies.

Boocock 2007 concluded that there was some evidence to support the use of mechanical and modifier interventions for preventing and managing neck or upper extremity musculoskeletal conditions. They found that there was moderate evidence that mouse and keyboard design can lead to positive health benefits in VDU workers with neck or upper extremity musculoskeletal conditions. Kennedy 2010 found moderate evidence for arm supports and limited evidence for ergonomics training plus workstation adjust-

Authors’ Conclusions

Implications for practice

The current available evidence demonstrates moderate-quality evidence to suggest that the use of an arm support together with an alternative mouse may reduce the incidence of neck or shoulder MSDs, but not right upper limb MSDs among VDU users. Moreover, there is moderate-quality evidence to suggest that the incidence of neck or shoulder and right upper limb MSDs is not reduced by using an alternative mouse as compared to a conventional mouse, with and without arm support. However, given that we made multiple comparisons involving a number of interventions and outcomes, high-quality evidence is needed to clearly determine the effectiveness of these interventions.

While there was very-low- to low-quality evidence to suggest that other ergonomic interventions do not prevent WRULDs, this was limited by the number and heterogeneity of available studies.

Implications for research

Given this review identified only a small number of studies with low risk of bias and significant heterogeneity between the studies, there is a need for high-quality RCTs examining ergonomic interventions for upper limb and neck disorders. Most of the studies were conducted in the US, with only three studies from Canada, and one each from Finland and Sweden. Studies from other parts of the world - especially from developing countries - are lacking. It is important to conduct these studies also in developing countries as differences in culture and work practices need to be also considered. Conducting multicentre studies in both developed and developing countries will further increase the usefulness of the findings.

The main risk for bias identified in this review was blinding (performance and detection bias). Although blinding of participants and personnel (performance bias) is difficult to achieve for ergonomic interventions, researchers need to consider minimising detection bias by having independent blinded assessors for diagnosing upper limb and neck MSDs. Future studies also need to consider including independent medical examinations for diagnosis or using injury records, workers’ compensation records or other injury reporting systems to obtain more objective outcome measures to minimise detection bias.

Studies used a number of different outcomes to measure discomfort and disability. The lack of standardisation in the methods used to assess these outcomes is obvious. Future research should there-
fore use standardised methods or validated instruments especially when assessing discomfort and disability.

The 13 identified studies consisted of only workers who used a computer or conducted data processing and worked in healthcare settings. Future research should include workers with other exposures or other industries where the risks for work-related MSDs are different.

The majority of studies did not report details of random sequence generation or allocation concealment. Future studies should have a clear description of the randomisation process and include both random sequence generation and allocation concealment to minimise selection bias.

Acknowledgements

The review authors would like to thank Dr Helen Handoll, Dr Jos Verbeek, Mr Jani Ruotsalainen, and Mrs Lindsey Elstub for valuable editorial comments on the protocol and review; Mrs Lesley Gillespie for assistance in developing the search strategies; and the editorial staff of the Cochrane Bone, Joint and Muscle Trauma Group and Cochrane Occupational Safety and Health review group for their assistance. The review authors would also like to thank Miranda Cupston and Jo McKenzie from the Australasian Cochrane Centre for their valuable assistance in the write-up and statistical input and Mr Jani Ruotsalainen from the Cochrane Occupational Safety and Health review group and Ms Anne Lawson from Wiley for copy editing the text.

References

References to studies included in this review

Bohr 2000 [published data only]

Brisson 1999 [published data only]

Conlon 2008 [published data only]

Galinsky 2000 [published and unpublished data]

Galinsky 2007 [published and unpublished data]

Gatty 2004 [published data only]

Greene 2005 [published data only]

Lintula 2001 [published data only]

McLean 2001 [published data only]

Rempel 2006 [published data only]

von Thiele 2008 [published data only]
References to studies excluded from this review

Aaras 1998 [published data only]

Cook 2004 [published data only]

Earl-Richardson 2006 [published data only]

Faucett 2002 [published data only]

Faucett 2007 [published data only]

Fostervold 2006 [published data only]

Haukka 2008 [published data only]

Ketola 2002 [published data only]

Meijer 2009 [published data only]

Mekhora 2000 [published data only]

Melhorn 1996 [published data only]

Pillastrini 2007 [published data only]

Rempel 2007 [published data only]

Veiersted 2008 [published data only]

References to ongoing studies

Driessen 2008 [published data only]

Additional references

Bernard 1994

Bernard 1997

Bonfiglioli 2006
Bonfiglioli R, Mattioli S, Spagnolo MR, Violante FS. Course of symptoms and median nerve conduction values...

**Boocock 2007**

**Buckle 1997**

**Buckle 1999**

**Cote 2008**

**Engela 1996**

**Furlan 2009**

**GRADE 2008**

**Higgins 2011**

**Hudak 1996**

**Huisteede 2006**

**Kennedy 2010**

**Kitis 2009**

**Lefebvre 2009**

**Marras 2009**

**Mathers 1999**

**NIOSH 1997**

**NIOSH 2001**

**Ortiz-Hernandez 2003**

**Ramazzini 1964**
**RevMan 2011**


**Shanahan 2006**


**Smith 2004**


**Szeto 2009**


**Tittiranonda 1999**


**USBJD 2008**


**Verhagen 2009**


**Werner 2005**


**Wynne-Jones 2009**


**Yassi 1997**


* Indicates the major publication for the study
## Characteristics of included studies  
*ordered by study ID*

### Bohr 2000

<table>
<thead>
<tr>
<th>Methods</th>
<th>RCT. The participants were randomly assigned to 1 of 3 study groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td>The sample of 154 subjects was selected at random from a list of volunteers who were employed as agents at the centralised reservation facility for a large international transportation company. These individuals used computers at least 5 hours per work day. All of these individuals performed similar work tasks at similar workstations</td>
</tr>
</tbody>
</table>
| Interventions | The study compared participatory education intervention, traditional education intervention, and no intervention  
  a. Participatory education intervention  
  It involved active learning sessions, incorporating discussions and problem-solving exercises to aid the participants in applying ergonomic concepts to the work environment. It should be noted that the content was similar to that provided to the traditional group but the method of presenting the information differed. The educational sessions for this group lasted approximately 2 hours  
  The first portion of the educational session incorporated hands-on demonstration of workstation evaluation and modification. Through case studies, the participants used a problem-solving approach to recognise ergonomic problems and recommend solutions to address the problem  
  The second portion of the session paired participants and returned them to their work areas to evaluate and modify the areas according to the information received during the first portion of the session. The modifications were made under the supervision of the instructor for the course who provided assistance to ensure that the newly arranged work areas were consistent with the principles taught in the class  
  b. Traditional education  
  It involved a 1-hour education session that consisted of a lecture and informational handouts about office ergonomics. The education for this group included information about basic muscle physiology, ideal neutral postures, basic task analysis, recommended office equipment location, recognition of problems related to incorrect equipment placement, and general wellness information related to exercise, nutrition, and smoking  
  A brief question and answer session was included at the end of the session  
  c. Control group/no intervention  
  The control group did not participate in any education sessions |
| Outcomes | Primary outcome: upper body pain/discomfort composite scores at baseline and at 3, 6, and 12 months’ postintervention. The discomfort scores range from 1 to 4 for each body part for pain and discomfort during the past week (1 = never, 2 = occasional, 3 = several times per week, 4 = several times per day). The upper body composite score included neck, upper back, shoulder/upper arm, forearm, and wrist/hand  
  Secondary outcome: compliance - work area configuration composite score at baseline and at 3, 6, and 12 months’ post-intervention |
### Risk of bias

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Unclear risk</td>
<td>The method of randomisation was not described in the study. The only information provided is: “The participants were randomly assigned to one of three study groups”</td>
</tr>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>Unclear risk</td>
<td>There was no information on allocation concealment</td>
</tr>
<tr>
<td>Blinding of participants and personnel (performance bias) All outcomes</td>
<td>High risk</td>
<td>Blinding of participants and personnel not possible as intervention included educational sessions</td>
</tr>
<tr>
<td>Blinding of outcome assessment (detection bias) Musculoskeletal disorders</td>
<td>High risk</td>
<td>Upper body pain/discomfort composite score was self-reported and subjective</td>
</tr>
<tr>
<td>Incomplete outcome data (attrition bias) All outcomes</td>
<td>High risk</td>
<td>The attrition rate was not even across the 3 groups. No ITT analysis mentioned. The attrition rate for both of the intervention groups was more than double that of the control group (23%-24% for the intervention groups vs 11% for the control group)</td>
</tr>
<tr>
<td>Selective reporting (reporting bias)</td>
<td>Low risk</td>
<td>Reported on all findings. According to the authors: “there were no significant differences noted across groups for work area configuration, worker postures, or overall observation scores”</td>
</tr>
</tbody>
</table>
| Other bias                    | High risk           | 1. Cross-contamination of intervention effects owing to close proximity of the workstations  
2. There was no information on baseline characteristics comparing the 2 intervention groups and the control group |
### Methods

Cluster RCT. Workers were assigned to the experimental or reference group (no intervention) on the basis of the units in which they worked. 40 administrative and geographic units were randomised to the experimental group or reference group. The units were stratified before randomisation on the basis of the number of clerical workers (< 20 and ≥ 20) and type of services (administrative and teaching) in order to ensure equal distribution of these features in each group.

### Participants

The study population composed of workers employed in a large university (90%) and in other institutions involved in university services (10%). Eligible workers were those working 5 hours or more per week with a VDU. 627 workers (81% of the people eligible at baseline) participated in both data collection periods (baseline and 6 months). They consists of:
- PRECEDE intervention group (n = 284)
- reference/no intervention group (n = 343)

### Interventions

The study compared PRECEDE intervention vs no intervention.

**a. PRECEDE intervention group**

The ergonomic training programme was developed according to the PRECEDE model. The objective of the programme was to act on characteristics of the work environment and the workers that determine behaviour in order to motivate and to enable the workers to improve the ergonomic features of their workstation.

- Predisposing factors relate to knowledge, beliefs, attitudes, and values
- Enabling factors relate to skills and material resources and
- Reinforcing factors relate to support provided by the environment

The programme targeted the following 3 types of behaviour:
- adjusting the postural components of the workstation correctly;
- adjusting the visual components of the workstation correctly; and
- organising work activities in a preventive manner

The programme composed of 2 sessions of 3 hours each with a 2-week interval.

1. The sessions involved demonstrations, simulations, discussions, and lectures. In addition, each worker had to do a self-diagnosis of his (her) workstation using a photograph taken of him (her) at work before the programme started. Each session was presented to about 15 workers with their supervisor at one time.
2. The presence of the supervisor aimed at providing an organisational environment that was supportive of actions taken by the workers.
3. The 2-week interval allowed the workers to apply knowledge and skills learned at the first session and to return to the second training session with questions and experiences to discuss.
4. The trainers were 4 occupational health and safety professionals working for the employer and 1 occupational health and safety union representative.

**b. Reference/no intervention group**

The reference group did not receive the training until the completion of the study.

### Outcomes

Primary outcome:

Neck-shoulder and hand-wrist musculoskeletal symptoms were assessed using a self-administered questionnaire and by physical examination. The measurements were performed 2 weeks before and 6 months after the intervention in both groups. The prevalent MSDs on the questionnaire were defined as those that were present on 3 days or more during the last 7 days and for which the intensity of pain was greater than half the VAS among subjects with no history of inflammatory disease or acute injury at the relevant...
The physical examination was performed on workers who reported symptoms meeting the case definition. The physical examination was conducted according to a standard protocol by a trained occupational therapist blinded to the participant’s assigned group. The physical examination was performed 2 to 5 weeks after the completion of the self-administered questionnaire.

### Secondary outcome:
Compliance with the intervention

### Notes
The information for the neck-shoulder and hand-wrist musculoskeletal symptoms was available for the 2 groups combined comparing before and after intervention, and for 3 anatomical regions combined (including lower back) comparing intervention and reference before and after intervention.

No information was available for neck-shoulder and hand-risk alone comparing the effect of intervention and reference group.

### Risk of bias

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors' judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Unclear risk</td>
<td>There was no information on sequence generation. The method for randomisation was clearly described</td>
</tr>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>Unclear risk</td>
<td>There was no information on allocation concealment</td>
</tr>
<tr>
<td>Blinding of participants and personnel (performance bias)</td>
<td>High risk</td>
<td>Participants were not blinded to the allocation as the intervention consisted of training</td>
</tr>
<tr>
<td>All outcomes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blinding of outcome assessment (detection bias)</td>
<td>High risk</td>
<td>Although the physical examination was performed by trained occupational therapists blinded to the subjects’ assigned group, the examination was only performed on workers who reported symptoms meeting the case definition which was based on self-reporting/subjective symptoms</td>
</tr>
<tr>
<td>Musculoskeletal disorders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incomplete outcome data (attrition bias)</td>
<td>Low risk</td>
<td>Although there was no mention of ITT, the percentages of participants were high at each measurement (88% and 94%). And according to the author “The percentages and reasons for non-participation were comparable in the experimental and reference groups”</td>
</tr>
<tr>
<td>All outcomes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Selective reporting (reporting bias)</td>
<td>Low risk</td>
<td>All outcomes were reported in the results</td>
</tr>
</tbody>
</table>
Conlon 2008

Methods

RCT. Participants were randomised into 1 of 4 intervention groups. The randomisation was done by means of a computer-generated permuted-block sequence.

Participants

Participants consists of employees working at a large aerospace engineering firm in California, US that estimated working at a computer for at least 20 hours per week and employed as an member of the engineering staff (93%) or a professional position supporting engineering (7%) and have completed the health questionnaire and at least 4 weekly surveys. Since 1 of the mouse interventions could only be used right-handed, only those who agreed to use their right hand for the mouse pointing device intervention were eligible for the study.

206 people volunteered out of total 437 eligible employees. The participants were randomised into 4 groups:

1. alternative mouse with a forearm support board (n = 51);
2. conventional mouse with a forearm support board (n = 51);
3. alternative mouse alone (n = 52);
4. conventional mouse alone (n = 52);

154 people volunteered for the nerve conduction testing.

Interventions

The study compared 4 different interventions for computer workstations:

1. Alternative mouse with a forearm support board: the forearm support board was a large butterfly-shaped board (36 by 21 inches) that was attached to a desk and provided padded forearm support (ButterflyBoard, Metamorphosis Design and Development, Atlanta, GA, US). The board was inclined upwards at approximately 5° and the surface could accommodate a keyboard and mouse, and the alternative mouse was a 3M product that had a vertical handle for grasping and a flat base to support the ulnar side of the hand and used a roller ball for tracking. The forearm was in approximately 15° of pronation during use (Renaissance Mouse, 3M Corporation, St Paul, MN, US).

2. Conventional mouse with a forearm support board: forearm support board (as in (1)) and conventional mouse used an optical LED for tracking the mouse movement and required the hand to be in an almost fully pronated posture during operation (IntelliMouse Optical, Microsoft Corporation, Redmond, WA, US).

3. Alternative mouse alone: the alternative mouse was a 3M product that had a vertical handle for grasping and a flat base to support the ulnar side of the hand and used a roller ball for tracking. The forearm was in approximately 15° of pronation during use (Renaissance Mouse, 3M Corporation, St Paul, MN, US) (as in (1)).

4. Conventional mouse alone: conventional mouse using an optical LED for tracking the mouse movement and required the hand to be in an almost fully pronated posture during operation (IntelliMouse Optical, Microsoft Corporation, Redmond, WA, US) (as in (2)).
Outcomes

Primary outcome:
1. Incidence of MSD: subject reported a discomfort intensity level of > 5 on the weekly survey, or used a pain medication for ≥ 2 days per week for upper body discomfort that they thought was related to computer work was referred for an examination. The examination protocol focused on the body region with discomfort and was performed by 1 physician who was blinded to the intervention status. The examination protocol assessed for the presence of 40 upper extremity and neck MSDs

2. Mean discomfort score: the discomfort scores were assessed for 3 body regions, the neck/shoulders, right elbow/forearm/wrist/hand, and left elbow/forearm/wrist/hand, were assessed for the worst discomfort during the preceding 7 days using a 0 to 10 point scale (0 = no discomfort; 10 = unbearable discomfort). Subjects were asked whether they thought the discomfort was the result of (a) working on a computer, (b) an acute injury at work, or (c) activities or an injury away from work. Only discomfort reported by the subject as a result of working on their computer was included in the data analysis. The mean discomfort scores for pre-intervention and post-intervention (pre-intervention mean discomfort scores were obtained from the weekly surveys before intervention by averaging all the pre-intervention scores for each subject to a single value; post-intervention discomfort scores were obtained from the weekly surveys after intervention. These scores were collapsed into a single postintervention score by body region. The first 8 weeks of post-intervention scores were left-censored)

Notes

The study was reported in 2 papers (see Conlon 2008)

Risk of bias

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Low risk</td>
<td>“Participants were randomised into one of four intervention groups. The randomisation was done by means of a computer-generated permuted-block sequence”</td>
</tr>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>Unclear risk</td>
<td>No information provided</td>
</tr>
<tr>
<td>Blinding of participants and personnel (performance bias)</td>
<td>High risk</td>
<td>Blinding of participants not possible given that different equipment was tested in the 4 groups</td>
</tr>
<tr>
<td>Blinding of outcome assessment (detection bias)</td>
<td>High risk</td>
<td>MSDs: although the examination was performed by 1 physician who was blinded to the intervention status, the pre-examination criteria for inclusion in the examination was determined by subjective discomfort levels</td>
</tr>
<tr>
<td>Incomplete outcome data (attrition bias)</td>
<td>Low risk</td>
<td>The analysis followed an ITT protocol. As participant exited the study they completed the exit questionnaire</td>
</tr>
</tbody>
</table>
Galinsky 2000

Methods

Cross-over RCT. Data was collected over a 16-week period. The 16-week period was divided into 4, 4-week phases in which participants alternated between the conventional (C) and supplementary (S) rest break schedules. Half of the volunteers from each shifts (day and night) were assigned at random to experience the C-S-C-S order of rest break schedules and the other half were assigned at random to experience the opposite (S-C-S-C) order. As a result of attrition, data from just the first 2 phases of the study were sufficient for analyses (i.e. the C-S phases).

Participants

Data-entry operators (seasonal employees) working at an Internal Revenue Service centre. The data-entry task entailed keying mostly numeric data from paper tax forms using a standard keyboard with a right-sided numeric keypad. A total of 101 data-entry operators provided written voluntary, informed consent to participate in the study. Each data-entry operator had been hired as a 'seasonal' employee under an agreement that the job was temporary. The time at which each operator was released from employment was determined by the workload demands of the facility.

Interventions

The study compared supplementary breaks with conventional breaks:
1. Control: the conventional break schedule included one 15-minute break in the middle of the first half of the work shift and one 15-minute break in the middle of the second half of the work shift.
2. Intervention: the supplementary break schedule included the same 15-minute breaks, and also included a 5-minute break during each hour of the work shift that otherwise did not contain a break. For each 8-hour shift, the supplementary schedule provided 4 extra 5-minute breaks for a total of 20 extra minutes of break time. Under each schedule, a 30-minute lunch period, additional to the 8-hour work and break time, occurred in the middle of the shift.
### Outcomes

**Primary outcome:**
1. Musculoskeletal discomfort ratings for several parts of the body, including the neck, shoulders, upper arms, elbows, forearms, wrists, hands, back, buttocks, and legs. Each rating was made using a 5-point category rating scale in which the whole numbers 1 to 5 indicated ratings of 'none at all', 'a little', 'moderate', 'quite a bit', and 'extreme', respectively.

**Secondary outcome:**
1. Data entry productivity: 2 measures of productivity, keystrokes per hour and the total number of documents entered by each participant on each day of the study. This measure, which was affected by factors such as the length of tax documents entered and the number of hours worked per day, permitted an assessment of work output.
2. Data accuracy: 2 measures of data-entry accuracy were used for this study. One was the number of errors made per day by each participant. The other was a daily measure of accuracy percentage, which took into account the number of documents entered per day.

### Risk of bias

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors' judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Unclear risk</td>
<td>There was no information on sequence generation. The only information available was: &quot;A within-subjects/repeated measures design was used … Half of the volunteers from each shift (day and night) were assigned at random to experience the C-S-C-S order of rest break schedules, and the other half were assigned at random to experience the opposite (S-C-S-C) order&quot;</td>
</tr>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>Unclear risk</td>
<td>There was no information on allocation concealment</td>
</tr>
<tr>
<td>Blinding of participants and personnel (performance bias)</td>
<td>Low risk</td>
<td>Blinding not possible, but the risk of performance bias was assessed as low as the intervention consisted of a strict protocol. The study participants &quot;...use custom-made electrical timers, attached to the top of each video display terminal, to automatically signal their scheduled breaks&quot;</td>
</tr>
<tr>
<td>Blinding of outcome assessment (detection bias)</td>
<td>High risk</td>
<td>The outcome has only subjective symptoms, i.e. musculoskeletal discomfort ratings (feeling state)</td>
</tr>
</tbody>
</table>
### Incomplete outcome data (attrition bias)

| All outcomes | High risk | Out of the 101 people who volunteered to participate in the study only 42 participants were included in the final analysis. Only the data from the first (first cross-over) of the 2 phases were sufficient for analysis. Data from the second phase (second cross-over) were not analysed. Loss to follow-up amounted to 38 participants and the reasons cited were release from employment and resignation from employment. Questionnaires from 21 participants were too incomplete for analyses |

### Selective reporting (reporting bias)

| Low risk | The outcomes listed in the methods section were reported in the results |

### Other bias

| Low risk | The authors reported that “to minimize the potential influence of carry-over effects and ‘Hawthorne effects’… Data from the first 2 weeks of each 4-week phase were excluded from analyses of the feeling state questionnaire items” |

---

### Galinsky 2007

#### Methods

Cross-over RCT. Approximately half (23) of the volunteers in each exercise condition were assigned at random to work for 4 weeks under conventional schedule and then switch to the supplementary schedule for the second 4-week phase. The remaining 22 volunteers in each exercise condition were assigned at random to experience the opposite sequence of rest break conditions.

#### Participants

Data-entry operators (seasonal employees) working at an Internal Revenue Service centre, Cincinnati, OH, US. The study sample was recruited from 1 area of the centre containing workstations for 101 individuals, 90 of whom volunteered to follow the study protocol.

#### Interventions

The study compared supplementary breaks with conventional breaks. Half of the 90 volunteers were assigned at random to the stretching exercise condition and half were assigned to the no stretching exercise condition. The 8-week study period was divided into two 4-week phases in which all participants alternated between the conventional and supplementary rest break schedules.

1. The conventional break schedule included one 15-minute break in the middle of the first half of the work shift and one 15-minute break in the middle of the second half of the work shift.

2. The supplementary break schedule included those same 15-minute breaks, and also included a 5-minute break during each hour of the work shift that otherwise did not contain a break. For each 8-hour shift, the supplementary schedule provided 4 extra 5-minute breaks for a total of 20 extra minutes of break time.

All participants were encouraged to get up and walk away from their workstations during...
each break, regardless of their assigned break schedule or exercise condition. Under each schedule, a 30-minute lunch period, additional to the 8 hours of work and break time, occurred in the middle of the shift. Participants in the exercise condition viewed a demonstration of the stretching exercises performed by the principal investigator with opportunities for questions and answers. They also kept a paper copy of exercise instructions at their workstations. They were instructed to do the stretches at the beginning of each break in the order specified in the instructions. The first 6 stretches were performed while seated and the last 3 stretches could be done while standing or walking. The 9 stretches required no more than 2 minutes to complete.

Outcomes

Primary outcome:
Musculoskeletal discomfort ratings (feeling state) for several parts of the body, including the neck, shoulders, upper arms, elbows, forearms, wrists, hands, back, buttocks, and legs. The musculoskeletal discomfort was made using a 5-point category rating scale in which the whole numbers 1 to 5 indicated ratings of 'none at all', 'a little', 'moderate', 'quite a bit', and 'extreme', respectively.

Notes

The data for the conventional and supplementary break cycle consists of the combination of participants in both exercise and no exercise groups. The effect of breaks alone cannot be isolated.

Risk of bias

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Unclear risk</td>
<td>There was no information on sequence generation. The only information available is that “… the exercise group and the non-exercise group… were assigned at random to work for 4 weeks under the Conventional schedule and then switch to the Supplementary schedule for the second 4-week phase” and “approximately half (23) of the volunteers in each exercise condition were assigned at random to work for 4 weeks under the Conventional schedule and then switch to the Supplementary schedule for the second 4-week phase”</td>
</tr>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>Unclear risk</td>
<td>There was no information on allocation concealment</td>
</tr>
</tbody>
</table>
| Blinding of participants and personnel (performance bias) All outcomes | Low risk           | Blinding was not possible but the risk of performance bias was deemed low for a rest-break cycle as the implementation consisted of a strict protocol. The participants “use custom-made electrical timers, attached to the top of each video display ter-
### Galinsky 2007

(Continued)

<table>
<thead>
<tr>
<th>Risk of Bias</th>
<th>High risk</th>
<th>Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blinding of outcome assessment (detection bias)</td>
<td>Musculoskeletal disorders</td>
<td>The outcome has only subjective symptoms, i.e. musculoskeletal discomfort ratings (feeling state)</td>
</tr>
<tr>
<td>Incomplete outcome data (attrition bias)</td>
<td>All outcomes</td>
<td>Out of the 90 who volunteered to follow the study protocol only 51 were deemed to have complete data for analysis. According to the text “An individual’s data set was deemed incomplete if more than 4 consecutive days of questionnaires were missing, or if more than a total of 8 days of questionnaires were missing from either the first or second 4-week period of the study”</td>
</tr>
<tr>
<td>Selective reporting (reporting bias)</td>
<td>Low risk</td>
<td>The risk of selective reporting (reporting bias) was deemed low as all outcome were reported, the author reported on non-significant outcome: “In the stretch group, workers reported stretching during only 25% of conventional breaks and 39% of supplementary breaks, and no significant effects of stretching on discomfort or performance were observed”</td>
</tr>
<tr>
<td>Other bias</td>
<td>High risk</td>
<td>There was no comparison of the 2 intervention groups. There was no mention of differences between participants and non-participants. Potential of carry-over effect, as the authors did not state having used a wash-out period</td>
</tr>
</tbody>
</table>

### Gatty 2004

<table>
<thead>
<tr>
<th>Method</th>
<th>RCT. The participants were randomly assigned to 1 of 2 groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td>“All participants were female and met the inclusion criteria by being employed as full-time clerical/office workers at a small western Pennsylvania college, and having no newly (within the last three months) diagnosed MSD”. 15 workers participated in the study</td>
</tr>
<tr>
<td>Interventions</td>
<td>The study compared individualised WIPPs vs no intervention 1. Individualised WIPPs (group A): the WIPP were designed by the WIPP team (3 master of occupational therapy students and the principle investigator) was based on</td>
</tr>
</tbody>
</table>

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_Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults (Review)_

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the worksite analyses. Treatment sessions spanned weeks 1 through to 4. Each participant received 1 hour of treatment per week. During these 4 sessions the workers were actively engaged in education, workstation redesign, and task modification

i) Education - occupational therapy students and clerical workers discussed current work conditions as they related to experienced symptoms; for example, improperly bending to lift boxes may contribute to low back pain or excessive wrist extension may contribute to wrist pain

ii) Workstation redesign - based on worksite analyses and input from the workers

iii) Task modification - demonstrated by the occupational therapy student, practiced by the worker, and feedback was provided

2. No intervention (control) (group B): this group received no intervention

All participants (intervention and control group) received the symptom evaluation measure (measured the reported frequency and intensity of symptoms), stress and energy scale (10-cm VAS to measure perceived stress energy levels), and follow-up survey (to identify changes in work status)

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Primary outcome:</th>
</tr>
</thead>
</table>
| Serum    | 1. frequency of symptoms: neck ache/pain, shoulder ache/pain, elbow-forearm ache/pain, wrist-hand ache/pain, upper back ache/pain, and lower back ache/pain defined as the number of days, 0 to 5, they experienced symptoms during the week while at work (data was collected at weeks 0, 5, and 16)

2. symptom intensity: rated using a 4-point Likert scale 1 to 4: 1 = none, 2 = mild, 3 = moderate, or 4 = severe

Secondary outcome:

Compliance survey - for group A (intervention) only - about: how often they used the issued ergonomic equipment, how often they performed recommended stretches and whether or not they performed their job duties differently based on recommendations.

Responses were elicited on a 4-point Likert scale with choices of 1 = never, 2 = sometimes, 3 = usually, 4 = always when I should

| Notes | The study was reported in 2 papers (see Gatty 2004);

1. Martin SA, Work 2003;21:185-96, reported results for weeks 0 and 5

2. Gatty CM, Work 2004;23:131-7, reported results for weeks 0, 5, and 16.

Worksite analyses were conducted for group B (control) workers during week 17, they received individualised WIPPs during weeks 18 to 21 and measures were repeated at week 22 (suspension of randomisation process)

<table>
<thead>
<tr>
<th>Risk of bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Unclear risk</td>
<td>There was no mention of sequence generation. The only information given was: “This was a two-phased randomized control pilot study with between and within subject comparisons … Participants were randomly assigned to one of two groups, A (intervention) or B (control)”</td>
</tr>
</tbody>
</table>
### Gatty 2004

(Continued)

<table>
<thead>
<tr>
<th>Bias Type</th>
<th>Risk Level</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>Unclear</td>
<td>No information provided on allocation concealment</td>
</tr>
<tr>
<td>Blinding of participants and personnel (performance bias)</td>
<td>High</td>
<td>There was no information on blinding and since the intervention consists of education, workstation redesign, and task modification, there was high risk for bias</td>
</tr>
<tr>
<td>Blinding of outcome assessment (detection bias)</td>
<td>High</td>
<td>The outcome was subjective reporting of symptoms frequency and intensity</td>
</tr>
<tr>
<td>Incomplete outcome data (attrition bias)</td>
<td>High</td>
<td>In group A (intervention), &quot;one non-compliant worker at week zero remained non-compliant at week five and was dropped from the study. One person was no longer employed by week 16 and membership decreased to six&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>In group B (control) &quot;...Although there were originally eight participants, two different workers were non-compliant with surveys, one at week zero and one at week five. By week 16, one person had left employment”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Owing to the small number of participants, i.e. 16, the attrition of 3 participants was considered to induce a high risk of bias</td>
</tr>
<tr>
<td>Selective reporting (reporting bias)</td>
<td>Low</td>
<td>All the outcomes were reported</td>
</tr>
<tr>
<td>Other bias</td>
<td>High</td>
<td>1. Difference in baseline data: group A (intervention) reported lower average wrist-hand ache/pain and upper back ache/pain intensities than group B (control)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. There was no mention of differences between participants and non-participants</td>
</tr>
</tbody>
</table>

### Gerr 2005

**Methods**

RCT. Randomisation occurred following evaluation of workplace and ergonomic variables. The use of a random number table assured that each subject entering the study had an equal probability of being assigned to each of the 3 groups. Randomisation was done in blocks of 6 to assure equal numbers of participants in each of the study groups.

**Participants**

A person eligible for inclusion in this study was: a newly hired worker who: anticipated using a single computer workstation for 15 hours or more per week and anticipated using a computer workstation for at least as many hours per week as in his/her previous job.


| Interventions | The study compared alternate intervention, conventional intervention, and no intervention. A study staff member reconfigured the subject’s workstation if the subject was randomly assigned to either the alternative or conventional interventions (groups A or B). Verbal and written instructions describing the desired posture were provided to all group A and B participants. At 3 days and 1 week after the intervention, study staff returned to the participant’s workplace to check on continued maintenance of the posture. If the posture had changed from the intervention, additional workstation changes were made and additional instruction given. 1. Group A: alternate intervention: the workstation was adjusted according to the following configuration:  
   i) Head tilt angle $\leq 3^\circ$ (head tilt angle is defined as the angle formed between a line defined by the tragion of the ear and the infraorbitale of the eye and the horizon. To clarify the meaning of head tilt angle values, increasing neck extension results in larger values for head tilt angle and increasing neck flexion results in smaller (including negative) values)  
   ii) head rotation $< 15^\circ$ in either direction (L/R)  
   iii) J key at least 2 cm below elbow height  
   iv) keyboard inner elbow angle of $> 120^\circ$  
   v) J key at least 12.5 cm from edge of desk or work surface  
   vi) keyboard wrist ulnar deviation of $0^\circ$ to $220^\circ$ (i.e. up to $20^\circ$ radial deviation)  
   vii) armrest present  
   viii) keyboard wrist rest present  
   ix) mouse wrist ulnar deviation of $25^\circ$ to $5^\circ$  
   x) mouse wrist extension of $20^\circ$ to $30^\circ$  
   xi) mouse next to keyboard  
   xii) high-quality chair present. Characteristics of high-quality chair: easily (pneumatically) adjustable for height, adjustable height backrest, full contoured backrest, adjustable seat pan angle, round waterfall seat pan edge, 5-legged base  
2. Group B: conventional intervention: the workstation was adjusted according to the following configuration:  
   i) eye height level with top of monitor screen  
   ii) head rotation $< 15^\circ$ in either direction (L/R)  
   iii) J key at least 3 cm above elbow height  
   iv) keyboard shoulder flexion of $210^\circ$ to $20^\circ$  
   v) keyboard shoulder abduction of $210^\circ$ to $20^\circ$  
   vi) keyboard inner elbow angle of $80^\circ$ to $100^\circ$  
   vii) keyboard wrist ulnar deviation of $210^\circ$ to $10^\circ$  
   viii) keyboard wrist extension of $210^\circ$ to $10^\circ$ |

working at insurance and financial companies, food product producers, and universities in metropolitan Atlanta, GA, US who had reported experiencing arm or hand symptoms during the week prior to intervention. Of the 447 eligible for health screening, a total of 379 individuals were eligible for inclusion into 1 or both cohorts (those who did not report experiencing arm or hand pain and neck or shoulder pain during the week prior to the study. 375 people were randomised into the arm and hand cohort and 356 were randomised into the neck and shoulder cohort.
Gerr 2005  

(Continued)

| ix) keyboard wrist rest present  |
| x) mouse wrist ulnar deviation of 210º to 10º  |
| xi) mouse wrist extension of 210º to 10º  |
| xii) armrest present  |
| xiii) high-quality chair present  |

3. Group C: no intervention: instructed to continue keying in their usual posture and no changes were made to their workstations.

Outcomes

Primary outcome:  
- Time to event: symptoms of pain or discomfort - participants were classified as having experienced musculoskeletal symptoms if they (1) reported musculoskeletal discomfort on any day of the week with a severity of ≥ 6 on the 0 to 10 VAS or (2) reported musculoskeletal discomfort on any day of the week for which they took medication (over-the-counter or prescription). Study participants were followed for each outcome separately until they became symptomatic (censored). Development of a symptom in 1 anatomic area did not stop the collection of data for the other anatomic area. 2 separate, overlapping cohorts were then defined to examine separately the risks of neck or shoulder symptoms and the risks of arm or hand symptoms.

Secondary outcome:  
- Compliance: using a standard checklist, each workstation was evaluated for presence of specific items (e.g. mouse or other pointing device), and the adjustability of specific equipment. Following completion of the checklist, dimensional and angular measurements (e.g. seated elbow height, table surface height, keyboard inner elbow angle) were recorded.

Notes

Gerr 2005 consists of 2 overlapping cohorts. The effect of the intervention was assessed as arm/hand and neck/shoulder pain.

Risk of bias

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Low risk</td>
<td>The use of a random number table assured that each subject entering the study had an equal probability of being assigned to each of the 3 groups. Randomisation was done in blocks of 6 to assure equal numbers of participants in each of the study groups.</td>
</tr>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>Unclear risk</td>
<td>No information on allocation concealment</td>
</tr>
<tr>
<td>Blinding of participants and personnel (performance bias) All outcomes</td>
<td>High risk</td>
<td>There was no mention of blinding and the methods of intervention consisted of 2 distinct workstation and postural interventions.</td>
</tr>
<tr>
<td>Blinding of outcome assessment (detection bias) Musculoskeletal disorders</td>
<td>High risk</td>
<td>Outcomes consisted of subjective symptoms measured with a check-list.</td>
</tr>
</tbody>
</table>

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### Gerr 2005 (Continued)

<table>
<thead>
<tr>
<th>Incomplete outcome data (attrition bias)</th>
<th>Low risk</th>
<th>Participants contributed data to their assigned intervention group regardless of compliance (i.e. data were analysed by ITT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selective reporting (reporting bias)</td>
<td>Low risk</td>
<td>Key findings: there were no significant differences in the incidence of musculoskeletal symptoms among the 3 intervention groups</td>
</tr>
<tr>
<td>Other bias</td>
<td>High risk</td>
<td>Large number of drop-outs. “There were a large number of drop-out/lost to follow-up in arm/hand cohort - 147 (41% of those followed) were lost during the six month follow up period … No differences were observed in dropout rates (i.e. incomplete follow-up) across the three intervention groups”. Although the drop-out rates were similar across the 3 randomised groups, there were a large number of drop-outs in each group (36 to 42 across all 6 groups) for which the authors did not provide a reason</td>
</tr>
</tbody>
</table>

### Greene 2005

**Methods**

RCT. A prospective 2-group experimental design with a delayed intervention for the control group was used (see Figure 1). Because the size of the training classes was limited to no more than 25, participants were randomly assigned to 1 of 4 training groups. 2 training groups were combined to form the intervention group and 2 training groups formed the control group. The RCT design was implemented only for the first 3 weeks of intervention. After the third week (week 4) the control group was given the active ergonomic training sessions. The participants were followed up for 1 year

**Participants**

Participants included all employees in the unit who worked at a computer at least 10 hours per week in an organisational unit of a large state university in southeast US. Employees diagnosed by a physician as having an acute musculoskeletal injury or trauma to the trunk or upper extremities within the previous 6 months were excluded from participation. Employees being treated by a healthcare professional for cervical or upper extremity disorders were excluded from participation. 87 employees participated in the study

**Interventions**

The study compared active ergonomic training with no intervention

1. AET: the AET programme consisted of a total of 6 hours of didactic interactions, discussion, and problem-based activities. The AET group met on 2 days in the same week for 3 hours per session. The AET programme occurred during working hours and employees participated on company time. Key elements of the AET programme were:
   i) skill development in problem-solving for ergonomic workstation issues
   ii) active participation and
iii) integration of multiple prevention strategies

2. No intervention (control): the participants did not receive intervention until week 4 of the study.

Outcomes

Primary outcome:
1. Musculoskeletal symptoms: participants were first asked if they had experienced musculoskeletal symptoms in the past year in: (a) head, (b) neck, (c) shoulder and upper arm, (d) elbow/forearm, (e) wrist, hands/fingers, or (f) upper back. Regional composite scores were computed to provide an impression of symptoms in a functional region. Scores from the head, neck, and upper back were combined to describe symptoms in the upper spine. Scores from the shoulder/upper arm, elbow/forearm, wrist, and hand were combined to describe symptoms in the upper extremity.

2. Intensity of pain: for each symptomatic body region, an ordinal scale was used ranging from 1 = mild pain to 4 = worst ever. A score of 0 was assigned for asymptomatic body regions.

3. Frequency of pain: an ordinal scale that ranged from 1 = once in the past week to 4 = daily in the past week was used. If no discomfort was present in a body region, a score of 0 was assigned.

4. Duration of pain: an ordinal scale that ranged from 1 = < 1 hour to 4 = > 3 days to 1 week was used. If no discomfort was present in a body region, a score of 0 was assigned.

Notes

The authors reported results for both the randomised and delayed intervention given to the control group (at week 4). From week 0 to week 3 the groups were treated according to their randomisation to the AET programme group and the control group. On week 4 the control group were also given the AET programme. We only included data from week 3.

Risk of bias

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>High risk</td>
<td>There was no information on sequence generation and the randomisation was not adhered to in the allocation of participants. “After participants were randomly assigned to groups, the physical proximity of participant work locations in the intervention and control groups was assessed. To minimize the diffusion of treatment effects, participants from the same work location were assigned to the same study group (intervention or control)”</td>
</tr>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>Unclear risk</td>
<td>There was no information on allocation concealment</td>
</tr>
</tbody>
</table>
**Greene 2005** (Continued)

<table>
<thead>
<tr>
<th>Bias Type</th>
<th>Risk Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blinding of participants and personnel</td>
<td>High risk</td>
<td>The participants and personnel were not blinded. The purpose of this study was to evaluate the effectiveness of an (AET programme in computer users. Subjects participated in a 6-hour training intervention at their workplace.</td>
</tr>
<tr>
<td>(performance bias) All outcomes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blinding of outcome assessment (detection</td>
<td>High risk</td>
<td>The outcome consists of subjective symptoms of pain or discomfort.</td>
</tr>
<tr>
<td>bias) Musculoskeletal disorders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incomplete outcome data (attrition bias) All</td>
<td>Unclear risk</td>
<td>There was no information on ITT analysis and loss to follow-up for the RCT part of the study. After the third week the control group were given the same intervention.</td>
</tr>
<tr>
<td>outcomes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Selective reporting (reporting bias)</td>
<td>Low risk</td>
<td>No significant differences were found for intensity of symptoms, frequency of symptoms, or duration of symptoms in any body region immediately post intervention.</td>
</tr>
<tr>
<td>Other bias</td>
<td>Unclear risk</td>
<td>There was no information on differences between participants and non-participants.</td>
</tr>
</tbody>
</table>

**Lintula 2001**

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methods</td>
<td>RCT. After the first measurements the participants were randomly assigned to 3 groups of 7 participants.</td>
</tr>
<tr>
<td>Participants</td>
<td>The participants were 21 healthy female VDU users without acute musculoskeletal symptoms. They were office employees and researchers with a mean age of 38 years (range 26 to 54 years). The participants had worked with a VDU for more than 20 hours a week for an average of 5 years (range 4 months to 13 years). All the participants were right-handed but 3 of them operated their mouse with their left hand.</td>
</tr>
</tbody>
</table>
| Interventions                    | The study compared Ergorest articulating arm supports with no arm support. Ergorest articulating arm supports (Ergorest Ltd, Finland) were used in this study. The arm supports are attached to the table, and the height of the supports can be adjusted. Both arms are settled in the grooves and there is easy mobility. Ergorest arm supports have been developed particularly to reduce static load in the neck and shoulder area.  
  - Group 1: “used the basic Ergorest arm support with the mouse pad with the hand that operated the mouse”  
  - Group 2: “had Ergorest arm supports for both hands (a basic arm support with the mouse pad for the mouse hand and the basic arm support for the other hand)”  
  - Group 3 (control): “had no arm supports, and they were asked to maintain their usual work technique and to avoid all redesign measures at work during the intervention” |
Outcomes

Primary outcome:
Musculoskeletal strain: the participants recorded the severity of their musculoskeletal strain using a VAS, each VAS was reported in millimetres (range 0 to 100 mm with end points of no strain and extreme strain). The mean value of the VAS lines obtained from the 6 body regions (neck, shoulder, upper arm, forearm, wrist, and hand and fingers) were calculated for the right and left sides.

Notes

Risk of bias

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Unclear risk</td>
<td>There was no information on sequence generation. The authors only mentioned that: “After the first measurements the participants were randomly assigned to three groups of 7 participants”</td>
</tr>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>Unclear risk</td>
<td>There was no information on allocation concealment</td>
</tr>
<tr>
<td>Blinding of participants and personnel</td>
<td>High risk</td>
<td>There was no mention of blinding and it may not even be possible as the intervention included supply of new equipment</td>
</tr>
<tr>
<td>(performance bias)</td>
<td></td>
<td>Musculoskeletal disorders</td>
</tr>
<tr>
<td>All outcomes</td>
<td></td>
<td>The outcome measure was subjective symptoms for muscle strain</td>
</tr>
<tr>
<td>Blinding of outcome assessment (detection bias)</td>
<td>High risk</td>
<td></td>
</tr>
<tr>
<td>Musculoskeletal disorders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incomplete outcome data (attrition bias)</td>
<td>Low risk</td>
<td>There was no loss to follow-up</td>
</tr>
<tr>
<td>All outcomes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Selective reporting (reporting bias)</td>
<td>Low risk</td>
<td>No statistically significant changes were observed in the musculoskeletal strain scores either between the groups or within the groups</td>
</tr>
<tr>
<td>Other bias</td>
<td>High risk</td>
<td>1. No comparison of groups on baseline characteristics specific to the outcome measures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. No comparison with non-participants</td>
</tr>
</tbody>
</table>
### McLean 2001

#### Methods

RCT. Participants were randomly assigned to 1 of 3 experimental groups

#### Participants

15 participants were recruited by word of mouth from the accounting (n = 6) and library (n = 6) offices at the University of New Brunswick and from New Brunswick Provincial Government Offices (n = 3) in Fredericton, NB, Canada. All participants were recruited based on their performance of jobs that involved sustained sitting postures in conjunction with keying and data entry tasks. 15 participants participated in the study.

#### Interventions

The study compared 3 different micro-break intervals:

- Upon obtaining informed consent, each participant’s workstation was examined for major problems in terms of ergonomic setup and such problems were corrected at least 1 month prior to participation.
- Ergobreak version 2.2 was installed on each participant’s computer at least 2 weeks prior to the data collection period. The programme was set to prompt users to take breaks based on fixed time intervals.
- Participants were randomly assigned to 1 of 3 experimental groups according to their set time interval between micro-breaks: all micro-breaks were of 30 seconds duration.
- Participants took part in the study over a 4-week period. For the first 2 weeks of participation (the ‘No Break’ protocol), subjects performed their usual work while minimising the amount of time spent away from their workstation. For the second 2-week period of participation each subject performed their assigned micro-break protocol with the assistance of the Ergobreak software. The programme was set to prompt participants to take breaks at their prescribed time intervals:
  1. Group 1: 40-minute interval group: all micro-breaks were of 30 seconds’ duration with the assistance of the Ergobreak software.
  2. Group 2: 20-minute interval group: all were of 30 seconds duration with the assistance of the Ergobreak software.
  3. Group 3: control group (where participants took breaks whenever they felt they needed to): the Ergobreak software was not set to prompt members of the control group.

#### Outcomes

Primary outcome:

Discomfort scores: “based on vertical visual analogue scales (VAS), The vertical scale was 100mm in length, and had no numerical anchors along its length with anchors at the top (Worst Possible Discomfort) and at the bottom (No Discomfort). VAS scores were measured by measuring the distance in millimetres between the ‘No Discomfort’ anchor and the location of the participant’s mark on the line. Four scales were placed on the same page and labelled ‘Neck’, ‘Low Back and Buttock’, ‘Shoulder and Upper Arm’ and ‘Forearm, Wrist and Hand’. For each body part, the difference in VAS scores (calculated as the VAS score at each measurement time during the No Breaks protocol minus the VAS score at that time during the Breaks protocol)”

Secondary outcome:

Productivity: the number of words typed (sets of 5 keystrokes) over the course of each 3-hour myoelectrical signal recording session. Word count data were collected at the end of each recording session only.

#### Notes

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### Risk of bias

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<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors' judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Unclear risk</td>
<td>There was no information on sequence generation. The only information available is… “Participants were randomly assigned to one of three experimental groups”</td>
</tr>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>Unclear risk</td>
<td>There was no information on allocation concealment</td>
</tr>
<tr>
<td>Blinding of participants and personnel (performance bias)</td>
<td>Low risk</td>
<td>There was no mention of blinding but the implementation of the micro-breaks followed a strict protocol: “Ergobreak version 2.2 was installed on each participant’s computer … the program was set to prompt users to take breaks based on fixed time intervals”</td>
</tr>
<tr>
<td>Blinding of outcome assessment (detection bias)</td>
<td>High risk</td>
<td>The discomfort outcome was subjective; “the discomfort score data were collected at 40 min intervals throughout the recording session”</td>
</tr>
<tr>
<td>Incomplete outcome data (attrition bias)</td>
<td>Unclear risk</td>
<td>There was no information on the total participants analysed in each group. Limited information on drop-outs. No statistical information on dealing with loss to follow-up</td>
</tr>
<tr>
<td>Selective reporting (reporting bias)</td>
<td>Low risk</td>
<td>All findings were reported including non-significant findings. For example, “no significant change in the frequency of MNF [mean frequency] cycling was noted at the shoulder”</td>
</tr>
<tr>
<td>Other bias</td>
<td>High risk</td>
<td>There was no information on the comparability of the VAS score at baseline between the groups and there was no data on the success of randomisation and comparability between the participants. The differences between all participants were presented and they showed very large differences in age and years of experience. “All participants were female (although this was not a requirement for participation), between the ages of 23 and 50 (median age 34). The number of years of experience working at a computer terminal or word processor ranged from two to 18 years (me-</td>
</tr>
</tbody>
</table>
### Rempel 2006

<table>
<thead>
<tr>
<th>Methods</th>
<th>RCT. This was a 1 year, randomised intervention trial with 4 treatment arms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td>Employees at 2 customer service centre sites (sites A and B) of a large healthcare company were eligible for participation if they performed computer-based customer service work for more than 20 hours per week and did not have an active workers' compensation claim involving the neck, shoulders, or upper extremities. 182 workers participated in the study</td>
</tr>
</tbody>
</table>
| Interventions    | The study compared 4 intervention arms. All the 4 treatment arms included ergonomics training. The ergonomics training involved conventional recommendations, which included maintaining an erect posture while sitting, adjusting the chair height so that the thighs were approximately parallel to the floor, adjusting the arm support and work surface height so that the forearms were approximately parallel to the floor, adjusting the mouse and keyboard location to minimise reaching, adjusting the monitor height so that the centre of the monitor is approximately 15º degrees below the visual horizon and a reminder to take scheduled breaks. The computer workstations used at the sites had independently adjustable keyboard and monitor support surfaces and were typically equipped with a conventional keyboard, computer mouse, and a telephone headset. Use of wrist rests at this workplace was optional. Subjects who were assigned to use the forearm support board could not continue to use a wrist rest owing to the design of the forearm support. Subjects not receiving the forearm support were allowed to continue using a wrist rest if they desired. Chairs were adjustable in height with adjustable height arm rests.  
1. Trackball with forearm support board: "the trackball (16.5 cm depth, 8.6 cm width, 4.6 cm height, with a 4 cm diameter ball; Marble Mouse, Logitech, Fremont, CA, US) was installed next to the keyboard. The armboard was a wraparound, padded arm support that attaches to the top, front edge of the work surface (30.5 cm depth, 76.2 cm width, 2.5 cm height; MorencyRest, R&D Ergonomics, Freeport, ME, US)".  
2. Forearm support board only: the armboard was a wraparound, padded arm support that attached to the top, front edge of the work surface (30.5 cm depth, 76.2 cm width, 2.5 cm height; MorencyRest, R&D Ergonomics, Freeport, ME, US) 
3. Trackball only: the trackball (16.5 cm depth, 8.6 cm width, 4.6 cm height, with a 4-cm diameter ball; Marble Mouse, Logitech, Fremont, CA, US) was installed next to the keyboard 
4. No intervention |
| Outcomes         | Primary outcome:  
1. incidence of upper extremity and neck MSDs: if subjects recorded on the weekly survey a pain intensity level of > 5 or they used medications for ≥ 2 days for upper extremity or neck pain that was not associated with an acute traumatic event (e.g. laceration, fall), then a physical examination of the upper extremities or neck/shoulders was performed by 1 physician who was blinded to intervention status. "An incident disorder was defined as a disorder diagnosed on the physical examination only if the
participant did not report pain > 5 in that body region (neck/shoulder, right upper extremity, left upper extremity) on the weekly questionnaire before the intervention.

2. worst pain during the preceding 7 days for neck/shoulder, right elbow/forearm/wrist/hand, and left elbow/forearm/wrist/hand assessed using a 0- to 10-point scale (0 = no pain; 10 = unbearable pain)

3. acute injury events during the week - weekly survey

Secondary outcome:
1. “The effect of the intervention on employee productivity was also assessed using the employer tracked measures of productivity”

### Risk of bias

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Low risk</td>
<td>Randomisation: “this was a one year, randomised intervention trial with four treatment arms”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sequence generation: “the randomisation was done by means of a computer generated permuted-block sequence and administered by a research associate”</td>
</tr>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>Unclear risk</td>
<td>No information provided</td>
</tr>
<tr>
<td>Blinding of participants and personnel (performance bias)</td>
<td>High risk</td>
<td>There was no blinding of participants or personnel. “This one year, randomised controlled intervention trial evaluated the effects of a wide forearm support surface and a trackball on upper body pain severity and incident musculoskeletal disorders among 182 call centre operators at a large healthcare company. Participants were randomised to receive (1) ergonomics training only, (2) training plus a trackball, (3) training plus a forearm support, or (4) training plus a trackball and forearm support”</td>
</tr>
<tr>
<td>All outcomes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blinding of outcome assessment (detection bias)</td>
<td>High risk</td>
<td>The outcomes included “worst pain during the preceding seven days”. Those who reported “pain intensity level of more than 5, or they used medications for two days” were subjected to a physical “examination protocol focused on the body region of pain and was performed by one physician who was blinded to intervention status.” Although the second part was blinded, it depended on the subjective reporting</td>
</tr>
<tr>
<td>Musculoskeletal disorders</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Incomplete outcome data (attrition bias)
All outcomes  Low risk  The analysis followed an ITT approach. The unavailability of 7 participants for a physical examination may have biased the findings. However, the hazard model for incident neck/shoulder disorders was repeated including these 7 participants as incident cases and the conclusions regarding the armboard were unchanged.

Selective reporting (reporting bias)  Low risk  Reported on all findings

Other bias  Low risk  The baseline characteristics of the participants did not significantly differ by intervention group

von Thiele 2008

Methods  Cluster RCT. Workplaces with a high (n = 3) and a low (n = 3) sickness absence were matched according to the number of employees. The matching resulted in 3 pairs that were randomly allocated to 1 of the 3 intervention groups.

Participants  Participants consisted of female employees from 6 workplaces in a large public dental healthcare organisation in Stockholm, Sweden. In all, 197 women employed at the 6 workplaces were invited to take part in the study. Of the women invited, 195 volunteered to participate.

Interventions  The study compared 3 intervention arms

1. Reduced work hours group: full-time weekly hours were reduced from 40 hours/week to 37.5 hours/week (reduced by 2.5 hours/week). For part-time employees and reduced work hours group, time for exercise/reduced work hours were set at 2 hours for those working 30 to 39 hours/week (39% of employee), 1.5 hours for 21 to 29 hours/week (14%), and 1 hour for < 20 hours/week (2%). Mandatory physical activity involved exercise of medium- to high-intensity corresponding to 55% to 89% of the person's maximum heart rate. The employees were free to choose any type of physical exercise.

2. Physical-exercise group: full-time employees with whom 2.5 hours weekly work hours were allocated to mandatory physical exercise on 2 different days

3. Reference group: no intervention

Outcomes  Primary outcome:

1. Musculoskeletal symptoms in the upper extremities: neck, shoulder, and hand-wrist were measured with the Standardized Nordic questionnaire. "For all items, the respondents were asked to indicate whether they had experienced symptoms or pain during the past 6 months." Sum scores were then computed. These ranged from 0 to 3, a high score indicating more symptoms.

2. Workability was measured using a single item. The respondents were asked to rate their current work ability as compared with their work ability at its best on a 10-point scale ranging from 'completely lacking work ability' (1) to 'work ability at its best' (10)
This report consists of 2 interventions (physical exercise and reduced work hours) and 1 control (reference group). For this review we only considered reduced work hours compared to reference group.

### Risk of bias

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Unclear risk</td>
<td>There was no information on sequence generation: “three workplaces with a high level of sickness absence and three with low levels, each employing at least 25 persons, were selected. Workplaces with a high and a low sickness absence were matched according to the number of employees. This matching resulted in three pairs that were randomly allocated to one of the following three groups”</td>
</tr>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>Unclear risk</td>
<td>There was no information on allocation concealment</td>
</tr>
<tr>
<td>Blinding of participants and personnel (performance bias)</td>
<td>High risk</td>
<td>The was no blinding. This study examined the health-related effects of 2 work-site interventions, physical exercise and reduced work hours, on women employed in dentistry</td>
</tr>
<tr>
<td>All outcomes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blinding of outcome assessment (detection bias) Musculoskeletal disorders</td>
<td>High risk</td>
<td>The outcomes were assessed as subjectively reported musculoskeletal symptoms</td>
</tr>
<tr>
<td>Incomplete outcome data (attrition bias)</td>
<td>High risk</td>
<td>There was no mention of ITT. The number volunteered (195 people) and analysed (177 people) was different. The distribution of participants in each group was uneven (physical exercise = 62 women, reduced work hours = 50 women, reference group = 65 employees/women). There was no description or comment on the unequal distribution. The total number of participants in each group who responded to the question on upper extremity disorder were different compared to the initial participants (exercise = 58 women, reduced hours = 43 women, reference = 59 women)</td>
</tr>
<tr>
<td>All outcomes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Selective reporting (reporting bias)</td>
<td>Low risk</td>
<td>All data were reported</td>
</tr>
</tbody>
</table>
### von Thiele 2008 (Continued)

<table>
<thead>
<tr>
<th>Other bias</th>
<th>Unclear risk</th>
<th>Differences between workplaces may have influenced the intervention</th>
</tr>
</thead>
</table>

### Yassi 2001

#### Methods
Cluster RCT: 3 wards each from medical (n = 3), surgical (n = 3), and rehabilitation (n = 3) were selected based on similarity with respect to type of patient, size of ward, staffing, and previous injury rates. Each of the 3 wards within a service area was then randomly assigned to 1 arm of the study. Thus, each arm consisted of 1 surgical unit, 1 medical unit, and 1 rehabilitation unit.

#### Participants
Nurses and unit assistants employed in medical, surgical, and rehabilitation wards at the Winnipeg's Health Science Centre, an acute and tertiary care hospital in Manitoba, Canada. This study is based on the 346 nurses and unit assistants employed on the 3 wards on July 1, 1998.

#### Interventions
The study compared 3 intervention arms:

1. **Arm C**: (no strenuous lifting programme)
   - i) moving patient from floor to bed/chair - mechanical total body lift,
   - ii) moving patient from bed to chair/bed - sit-stand lift/mechanical total body lift,
   - iii) moving patient from bed to stretcher/stretcher to bed - slide devices,
   - iv) moving patient from bed - slide devices,
   - v) walking with patient - not addressed by equipment or training

2. **Arm B**: (safe lifting programme)
   - i) moving patient from floor to bed/chair - mechanical total body lift,
   - ii) moving patient from bed to chair/bed - transfer belt/mechanical total body lift,
   - iii) moving patient from bed to stretcher/stretcher to bed - slide devices,
   - iv) moving patient from bed - slide devices,
   - v) walking with patient - transfer belts

3. **Arm A**: (control)
Usual practice for all procedures

Training
Staff received training in body mechanics or lifting techniques only on request and received training only for equipment in regular use on those wards.

Equipment provided:
1. 1 mechanical total body lift (in ward)
2. Access to sliding devices (from a central equipment depot on request only)

Training
Completed before the start of the study. Received 3 hours of intensive problem-based hand-on education on back care, patient assessment, handling techniques, and practice of using equipment in wards.

Equipment provided:
1. 1 mechanical total body lift available on the ward
2. Transfer belts were available in each room
3. 2 large and 4 small sliding devices (in each ward)

Training
Completed before the start of the study. Received 3 hours of intensive problem-based hand-on education on back care, patient assessment, handling techniques, and practice of using equipment in wards

Equipment provided:
1. new mechanical total body lifts
2. new sit-stand lifts
3. a set of sliding devices in each room

The number of mechanical lifts allocated to each arm C ward was determined by an evaluation that considered the patient population on that ward and the types of lifts and transfers commonly used:
1. rehabilitation wards were provided with 3 sit-stand lifts and 2 total body lifts
2. medical wards received 2 sit-stand lifts and 2 total body lifts and
3. surgical wards received 1 of each

Outcomes
Primary outcome:
1. musculoskeletal symptoms: shoulder pain was measured with the question "As a result of work, in the past week how often have you experienced shoulder pain?" Responses were given on a 0-100 VAS, which was scored such that lowest safety/comfort was 0 and highest was 100
2. musculoskeletal injuries: "All reported musculoskeletal injuries between July 1, 1998 and June 30, 1999 incurred during patient-handling task .... Only reports documenting an incident involving a patient lift or transfer were included in this analysis ... The number of reported musculoskeletal injuries, injury rate for all injuries, time loss injuries per 100,000 paid hours, total costs associated with injuries, and cost per time loss injury were calculated for the nine wards during the year of the study, during the previous year, and averaged over the 3 years before the study"
3. DASH questionnaire: the details of the measure were not available in the paper or in the article referred to by the authors (Hudak 1996)

Secondary outcomes:
1. cost of musculoskeletal injuries, total, and time lost injuries: "data from Workers Compensation Board files (includes wage replacement, medical, rehabilitation for injured workers) ... The number of reported musculoskeletal injuries, injury rate for all injuries, time loss injuries per 100,000 paid hours, total costs associated with injuries, and cost per time loss injury were calculated for the nine wards during the year of the study, during the previous year, and averaged over the 3 years before the study"
2. compliance: number of equipment used

Notes
The study assessed the effect of the intervention on the low back and shoulder regions. For this review we only considered the shoulder region

Risk of bias

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
</table>
| Random sequence generation (selection bias) | Unclear risk | There was no information on sequence generation. "Each of the three wards within a service area was then randomly assigned
Yassi 2001  

(Continued)

<table>
<thead>
<tr>
<th>Risk of Bias Category</th>
<th>Risk of Bias</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>Unclear risk</td>
<td>There was no information on allocation concealment</td>
</tr>
<tr>
<td>Blinding of participants and personnel (performance bias)</td>
<td>High risk</td>
<td>Blinding was not possible as the intervention was based on training and equipment</td>
</tr>
</tbody>
</table>

…”The nine wards in this study are physically separate within the facility … Arm A wards were designated as control, Arm B wards adopted a “safe lifting” program; "usual practice," as per HSC practice; Arm C wards adopted a "no strenuous lifting" program”

<table>
<thead>
<tr>
<th>Risk of Bias Category</th>
<th>Risk of Bias</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blinding of outcomes assessment (detection bias)</td>
<td>High risk</td>
<td>The outcomes assessed were subjective musculoskeletal symptoms and self-perceived frequency and intensity of physical discomfort. Injury data consisted of: “All reported musculoskeletal injuries between July 1, 1998 and June 30, 1999 incurred during patient-handling tasks were followed up. Only reports documenting an incident involving a patient lift or transfer were included in this analysis. Injured participants were interviewed to determine their ratings of self-perceived pain (VAS scale) and disability (Oswestry and DASH) &quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Risk of Bias Category</th>
<th>Risk of Bias</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incomplete outcome data (attrition bias)</td>
<td>High risk</td>
<td>There was no information on ITT. The distribution of the 3 groups is different and the attrition from each measurement time was not discussed Arm A: baseline n = 103, 6 months n = 95, 1 year n = 82 Arm B: baseline n = 116, 6 months n = 99, 1 year n = 85 Arm C: baseline n = 127, 6 months n = 109, 1 year n = 94</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Risk of Bias Category</th>
<th>Risk of Bias</th>
<th>Reason</th>
</tr>
</thead>
</table>
| Selective reporting (reporting bias)          | Low risk     | All results were reported including non-significant results. "Musculoskeletal injury rates were not significantly altered ... The fact that injury rates were not statistically
significant reduced may reflect the less sensitive nature of this indicator compared with the subjective indicators’

| Other bias          | High risk | The baseline demographic data was not reported, so the success of randomisation cannot be ascertained |

AET: active ergonomic training; DASH: Disability of the Arm, Shoulder and Hand; ITT: intention to treat; LED: light-emitting diode; PRECEDE: predisposing, reinforcing and enabling causes in educational diagnosis evaluation; RCT: randomised controlled trial; VAS: visual analogue scale; VDU: visual display unit; vs: versus; WIPP: work injury prevention programme.

### Characteristics of excluded studies

[ordered by study ID]

<table>
<thead>
<tr>
<th>Study</th>
<th>Reason for exclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aaras 1998</td>
<td>The study was a parallel group design. There was no mention of randomisation in the method section. The intervention groups were allocated according to where they work: “Two groups, one from Technical division (T group) and one from Software delivery (S group) ...”</td>
</tr>
<tr>
<td>Cook 2004</td>
<td>The aim of this study was to determine whether providing forearm support when using a normal computer workstation would decrease musculoskeletal discomfort in intensive computer users in a call centre and 75% of the participants reported discomfort in the 7 days preceding study commencement</td>
</tr>
<tr>
<td>Earl-Richardson 2006</td>
<td>There is no separate outcome for neck and the upper limb</td>
</tr>
<tr>
<td>Faucett 2002</td>
<td>73% of participants reported symptoms of pain, stiffness, or numbness at baseline</td>
</tr>
<tr>
<td>Faucett 2007</td>
<td>There is no separate outcome for neck and the upper-limb, only for musculoskeletal symptoms</td>
</tr>
<tr>
<td>Fostervold 2006</td>
<td>&gt; 25% of the participants had neck and shoulder symptoms at baseline. The prevalence of neck and shoulder symptoms at baseline was 73.5% in the intervention group and 75% in the comparison group</td>
</tr>
<tr>
<td>Haukka 2008</td>
<td>&gt; 25% of the participants had neck pain, shoulder pain, and forearm/hand pain at baseline. The prevalence of neck pain, shoulder pain, and forearm/hand pain at baseline ranged from 34% to 79% in the intervention and control groups</td>
</tr>
<tr>
<td>Ketola 2002</td>
<td>The study included subjects with musculoskeletal symptoms: “One hundred and twenty-four subjects with musculoskeletal symptoms were selected”</td>
</tr>
<tr>
<td>Meijer 2009</td>
<td>&gt; 25% of the participants had upper extremity musculoskeletal symptoms at baseline. Prevalence for the control group was 49% and 36% for the intervention group</td>
</tr>
</tbody>
</table>
Melhorn 2000
1. The participants were randomised in the first part of study, then the ‘control’ group was given the same intervention. Data were not available for the first part of the study to compare between intervention and control group
2. The participants were selected based on “those with above average discomfort and who had discomfort around the neck and shoulder areas for more than 1 day in the previous year”

Melhorn 1996
The report aimed to look at change in risk level for upper-extremity cumulative trauma disorders and did not report on musculoskeletal symptoms

Pillastrini 2007
This is not an RCT. The allocation of intervention consists of “… randomly assigned 100 participants from the first building to group E (which received an ergonomic intervention plus an informative brochure) and randomly assigned 100 participants from the second building to group I (which received only the brochure).” There was no information on the methods they used to select the buildings as intervention and control

Rempel 2007
The participants only included those who reported neck/shoulder pain in the past month at baseline

Veiersted 2008
> 25% of the participants had neck and shoulder discomfort or pain at baseline. The prevalence for neck pain or discomfort in the last 7 days was 28% (intervention group I) and 20% (intervention group II). The prevalence for shoulder pain or discomfort, or both, in the last 7 days was 39% (intervention group I) and 30% (intervention group II)

RCT: randomised controlled trial.

Characteristics of ongoing studies [ordered by study ID]

Driessen 2008

<table>
<thead>
<tr>
<th>Trial name or title</th>
<th>Stay@Work</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methods</td>
<td>Cluster RCT</td>
</tr>
<tr>
<td>Participants</td>
<td>Participants are workers, both blue and white collar workers, recruited from the departments of 4 large Dutch companies with at least 3000 workers each. The companies included are a railway transportation company, an airline company, a university including its university medical hospital, and a steel company</td>
</tr>
</tbody>
</table>
| Interventions       | Intervention group: workers allocated to the intervention departments watch the same movies about the prevention of LBP and NP as the control group. In addition, they receive the Stay@Work PE programme. One of the main characteristics of PE is the formation of a ‘working group’ in which both workers and management participate as members. The 6 steps of the Stay@Work PE programme are followed during 2 meetings with the working group
  • Step 1: inventory of the workplace
  • Step 2: analysis of risk factors
  • Step 3: finding of ergonomic measures
  • Step 4: preparation of an implementation plan
  • Step 5: implementation of ergonomic measures
  • Step 6: evaluation and control of the ergonomic measures |
Control group: workers allocated to the control departments are asked to watch 3 short (45 seconds) web-based educative movies about the prevention of LBP and NP at the campaign web site of ‘Lighten the load, a European Campaign on Musculoskeletal Disorders’ developed by the European Agency for Safety and Health at Work.

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Primary outcome:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. an episode of NP: the presence of NP during a recall period of 3 months followed and preceded by a recall period of 3 months without NP. The transition from a symptom free period to a new episode of NP is modelled as the outcome</td>
</tr>
<tr>
<td></td>
<td>2. intensity of pain: the intensity of pain (i.e. pain at the moment of filling out the questionnaire, average pain, and most severe pain experienced in the past 3 months), and the pain duration (total days of pain experienced in the past 3 months) owing to NP is measured using von Korff scales</td>
</tr>
<tr>
<td>Secondary outcome:</td>
<td>1. sick leave and work productivity</td>
</tr>
<tr>
<td></td>
<td>2. actual use of ergonomic equipment</td>
</tr>
</tbody>
</table>

Starting date: Data collection started in November 2007

Contact information:
- Maurice T Driessen* - m.driessen@vumc.nl
- Johannes R Anema - h.anema@vumc.nl
- Karin I Proper - ki.proper@vumc.nl
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- Allard J van der Beek - a.vanderbeek@vumc.nl

Notes:
- LBP: low back pain; NP: neck pain; PE: participatory ergonomics; RCT: randomised controlled trial

LBP: low back pain; NP: neck pain; PE: participatory ergonomics; RCT: randomised controlled trial
## Data and Analyses

### Comparison 1. An arm support together with an alternative mouse versus a conventional mouse alone

<table>
<thead>
<tr>
<th>Outcome or subgroup title</th>
<th>No. of studies</th>
<th>No. of participants</th>
<th>Statistical method</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Incidence of neck/shoulder disorder</td>
<td>2</td>
<td>186</td>
<td>Risk Ratio (M-H, Random, 95% CI)</td>
<td>0.52 [0.27, 0.99]</td>
</tr>
<tr>
<td>2 Incidence of right upper limb disorder</td>
<td>2</td>
<td>181</td>
<td>Risk Ratio (M-H, Random, 95% CI)</td>
<td>0.73 [0.32, 1.66]</td>
</tr>
<tr>
<td>3 Incidence of upper body disorders (neck, shoulder, and upper limb)</td>
<td>2</td>
<td>191</td>
<td>Risk Ratio (M-H, Random, 95% CI)</td>
<td>0.66 [0.42, 1.04]</td>
</tr>
<tr>
<td>4 Neck/shoulder discomfort score</td>
<td>2</td>
<td>194</td>
<td>Std. Mean Difference (IV, Random, 95% CI)</td>
<td>-0.41 [-0.69, -0.12]</td>
</tr>
<tr>
<td>5 Right upper extremity discomfort score</td>
<td>2</td>
<td>194</td>
<td>Std. Mean Difference (IV, Random, 95% CI)</td>
<td>-0.34 [-0.63, -0.06]</td>
</tr>
</tbody>
</table>

### Comparison 2. An alternative mouse alone versus a conventional mouse alone

<table>
<thead>
<tr>
<th>Outcome or subgroup title</th>
<th>No. of studies</th>
<th>No. of participants</th>
<th>Statistical method</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Incidence of neck/shoulder disorder</td>
<td>2</td>
<td>182</td>
<td>Risk Ratio (M-H, Random, 95% CI)</td>
<td>0.62 [0.19, 2.00]</td>
</tr>
<tr>
<td>2 Incidence of right upper extremity disorder</td>
<td>2</td>
<td>182</td>
<td>Risk Ratio (M-H, Random, 95% CI)</td>
<td>0.91 [0.48, 1.72]</td>
</tr>
<tr>
<td>3 Incidence of upper body disorder (neck, shoulder, and upper extremity)</td>
<td>2</td>
<td>190</td>
<td>Risk Ratio (M-H, Random, 95% CI)</td>
<td>0.79 [0.52, 1.21]</td>
</tr>
<tr>
<td>4 Neck/shoulder discomfort score</td>
<td>2</td>
<td>195</td>
<td>Std. Mean Difference (IV, Random, 95% CI)</td>
<td>0.04 [-0.26, 0.33]</td>
</tr>
<tr>
<td>5 Right upper extremity discomfort score</td>
<td>2</td>
<td>195</td>
<td>Std. Mean Difference (IV, Random, 95% CI)</td>
<td>0.00 [-0.28, 0.28]</td>
</tr>
</tbody>
</table>

### Comparison 3. An arm support together with a conventional mouse versus a conventional mouse alone

<table>
<thead>
<tr>
<th>Outcome or subgroup title</th>
<th>No. of studies</th>
<th>No. of participants</th>
<th>Statistical method</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Incidence of neck/shoulder disorder</td>
<td>2</td>
<td>186</td>
<td>Risk Ratio (M-H, Fixed, 95% CI)</td>
<td>0.67 [0.36, 1.24]</td>
</tr>
<tr>
<td>2 Incidence of right upper extremity disorders</td>
<td>2</td>
<td>178</td>
<td>Odds Ratio (M-H, Random, 95% CI)</td>
<td>1.09 [0.51, 2.29]</td>
</tr>
</tbody>
</table>
### Comparison 4. An alternative mouse with an arm support versus a conventional mouse with an arm support

<table>
<thead>
<tr>
<th>Outcome or subgroup title</th>
<th>No. of studies</th>
<th>No. of participants</th>
<th>Statistical method</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Incidence of neck/shoulder disorder</td>
<td>2</td>
<td>182</td>
<td>Risk Ratio (M-H, Random, 95% CI)</td>
<td>0.76 [0.22, 2.63]</td>
</tr>
<tr>
<td>2 Incidence of right upper limb disorder</td>
<td>2</td>
<td>175</td>
<td>Risk Ratio (M-H, Random, 95% CI)</td>
<td>0.76 [0.37, 1.59]</td>
</tr>
<tr>
<td>3 Incidence of upper body disorders (neck, shoulder, and upper limb)</td>
<td>2</td>
<td>190</td>
<td>Risk Ratio (M-H, Random, 95% CI)</td>
<td>0.77 [0.36, 1.63]</td>
</tr>
<tr>
<td>4 Neck/shoulder discomfort score</td>
<td>2</td>
<td>193</td>
<td>Std. Mean Difference (IV, Random, 95% CI)</td>
<td>-0.39 [-0.67, -0.10]</td>
</tr>
<tr>
<td>5 Right upper extremity discomfort score</td>
<td>2</td>
<td>193</td>
<td>Std. Mean Difference (IV, Random, 95% CI)</td>
<td>-0.27 [-0.55, 0.02]</td>
</tr>
</tbody>
</table>

### Comparison 5. Supplementary breaks versus normal breaks

<table>
<thead>
<tr>
<th>Outcome or subgroup title</th>
<th>No. of studies</th>
<th>No. of participants</th>
<th>Statistical method</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 After shifts discomfort rating for neck (4-8 weeks)</td>
<td>2</td>
<td>186</td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>-0.25 [-0.53, 0.02]</td>
</tr>
<tr>
<td>2 After shifts discomfort ratings for right shoulder/upper arm (4-8 weeks)</td>
<td>2</td>
<td>186</td>
<td>Mean Difference (IV, Random, 95% CI)</td>
<td>-0.24 [-0.51, 0.03]</td>
</tr>
<tr>
<td>3 After shifts discomfort ratings for right forearm/wrist/hand (4-8 weeks)</td>
<td>2</td>
<td>186</td>
<td>Mean Difference (IV, Random, 95% CI)</td>
<td>-0.19 [-0.45, 0.08]</td>
</tr>
</tbody>
</table>
### Comparison 6. Reduce work hours versus normal work hours

<table>
<thead>
<tr>
<th>Outcome or subgroup title</th>
<th>No. of studies</th>
<th>No. of participants</th>
<th>Statistical method</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Upper extremity disorder (6 months)</td>
<td>1</td>
<td>102</td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>0.08 [-0.32, 0.48]</td>
</tr>
<tr>
<td>2 Upper extremity disorder (12 months)</td>
<td>1</td>
<td>102</td>
<td>Mean Difference (IV, Random, 95% CI)</td>
<td>0.22 [-0.22, 0.66]</td>
</tr>
<tr>
<td>3 Work ability (6 months)</td>
<td>1</td>
<td>104</td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>0.41 [-0.28, 1.10]</td>
</tr>
<tr>
<td>4 Work ability (12 months)</td>
<td>1</td>
<td>104</td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>0.5 [-0.23, 1.23]</td>
</tr>
</tbody>
</table>

### Comparison 7. Ergonomic training versus no intervention

<table>
<thead>
<tr>
<th>Outcome or subgroup title</th>
<th>No. of studies</th>
<th>No. of participants</th>
<th>Statistical method</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Neck/shoulder musculoskeletal symptoms by medical examination</td>
<td>1</td>
<td>499</td>
<td>Risk Ratio (M-H, Fixed, 95% CI)</td>
<td>1.19 [0.66, 2.14]</td>
</tr>
<tr>
<td>2 Hand/wrist symptoms by medical examination</td>
<td>1</td>
<td>509</td>
<td>Risk Ratio (M-H, Fixed, 95% CI)</td>
<td>1.39 [0.41, 4.74]</td>
</tr>
<tr>
<td>3 Intensity of upper extremity pain</td>
<td>1</td>
<td>82</td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>0.08 [-0.22, 0.38]</td>
</tr>
<tr>
<td>4 Frequency of upper extremity pain</td>
<td>1</td>
<td>82</td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>-0.03 [-0.45, 0.39]</td>
</tr>
<tr>
<td>5 Duration of upper extremity pain</td>
<td>1</td>
<td>82</td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>0.13 [-0.25, 0.51]</td>
</tr>
</tbody>
</table>

### Comparison 8. Work injury prevention programme versus no intervention

<table>
<thead>
<tr>
<th>Outcome or subgroup title</th>
<th>No. of studies</th>
<th>No. of participants</th>
<th>Statistical method</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Frequency of neck ache or pain</td>
<td>1</td>
<td>13</td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>-1.2 [-2.77, 0.37]</td>
</tr>
<tr>
<td>2 Frequency of shoulder ache or pain</td>
<td>1</td>
<td>13</td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>-1.1 [-2.65, 0.45]</td>
</tr>
<tr>
<td>3 Frequency of wrist/hand ache or pain</td>
<td>1</td>
<td>13</td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>-1.0 [-2.52, 0.52]</td>
</tr>
<tr>
<td>4 Intensity of neck ache or pain</td>
<td>1</td>
<td>13</td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>-0.30 [-1.19, 0.59]</td>
</tr>
<tr>
<td>5 Intensity of shoulder ache or pain</td>
<td>1</td>
<td>13</td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>-0.20 [-0.91, 0.51]</td>
</tr>
<tr>
<td>6 Intensity of wrist/hand ache or pain</td>
<td>1</td>
<td>13</td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>-0.20 [-1.17, 0.77]</td>
</tr>
</tbody>
</table>
### Comparison 9. Patient lifting/transfer intervention versus normal practice

<table>
<thead>
<tr>
<th>Outcome or subgroup title</th>
<th>No. of studies</th>
<th>No. of participants</th>
<th>Statistical method</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Shoulder pain (safe lifting versus usual practice)</td>
<td>1</td>
<td>166</td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>3.0 [-4.83, 10.83]</td>
</tr>
<tr>
<td>2 Shoulder pain (no strenuous lifting versus usual practice)</td>
<td>1</td>
<td>175</td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>0.10 [-7.62, 7.82]</td>
</tr>
<tr>
<td>3 DASH (no lifting versus usual practice)</td>
<td>1</td>
<td>166</td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>1.0 [-2.32, 4.32]</td>
</tr>
<tr>
<td>4 DASH (no strenuous lifting)</td>
<td>1</td>
<td>175</td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>-0.80 [-3.75, 2.15]</td>
</tr>
</tbody>
</table>

### Analysis 1.1. Comparison 1 An arm support together with an alternative mouse versus a conventional mouse alone, Outcome 1 Incidence of neck/shoulder disorder.

Review: Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

Comparison: 1 An arm support together with an alternative mouse versus a conventional mouse alone

Outcome: 1 Incidence of neck/shoulder disorder

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Alternative mouse</th>
<th>Conventional mouse</th>
<th>Risk Ratio M-H, Random, 95% CI</th>
<th>Weight</th>
<th>Risk Ratio M-H, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rempel 2006</td>
<td>8/40</td>
<td>19/43</td>
<td>82.9 %</td>
<td>0.45</td>
<td>[0.22, 0.92]</td>
</tr>
<tr>
<td>Conlon 2008</td>
<td>3/51</td>
<td>3/52</td>
<td>17.1 %</td>
<td>1.02</td>
<td>[0.22, 4.82]</td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td>91</td>
<td>95</td>
<td><strong>100.0 %</strong></td>
<td><strong>0.52</strong></td>
<td>[<strong>0.27, 0.99</strong>]**</td>
</tr>
</tbody>
</table>

Total events: 11 (Alternative mouse), 22 (Conventional mouse)
Heterogeneity: Tau² = 0.0; Chi² = 8.88, df = 1 (P = 0.35); I² = 0.0%
Test for overall effect: Z = 2.00 (P = 0.046)
Test for subgroup differences: Not applicable
### Analysis 1.2. Comparison 1 An arm support together with an alternative mouse versus a conventional mouse alone, Outcome 2 Incidence of right upper limb disorder.

Review: Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

Comparison: 1 An arm support together with an alternative mouse versus a conventional mouse alone

Outcome: 2 Incidence of right upper limb disorder

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Alternative mouse</th>
<th>Conventional mouse</th>
<th>Risk Ratio</th>
<th>Weight</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n/N</td>
<td>n/N</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M-H, Random, 95% CI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rempel 2006</td>
<td>7/38</td>
<td>7/40</td>
<td>56.1 %</td>
<td>1.05</td>
<td>[0.41, 2.72]</td>
</tr>
<tr>
<td>Conlon 2008</td>
<td>4/51</td>
<td>9/52</td>
<td>43.9 %</td>
<td>0.45</td>
<td>[0.15, 1.38]</td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>89</strong></td>
<td><strong>92</strong></td>
<td><strong>100.0 %</strong></td>
<td><strong>0.73</strong></td>
<td>[0.32, 1.66]</td>
</tr>
</tbody>
</table>

Total events: 11 (Alternative mouse), 16 (Conventional mouse)
Heterogeneity: Tau² = 0.08; Chi² = 1.28, df = 1 (P = 0.26); I² = 22%
Test for overall effect: Z = 0.76 (P = 0.45)
Test for subgroup differences: Not applicable

### Analysis 1.3. Comparison 1 An arm support together with an alternative mouse versus a conventional mouse alone, Outcome 3 Incidence of upper body disorders (neck, shoulder, and upper limb).

Review: Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

Comparison: 1 An arm support together with an alternative mouse versus a conventional mouse alone

Outcome: 3 Incidence of upper body disorders (neck, shoulder, and upper limb)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Alternative mouse</th>
<th>Conventional mouse</th>
<th>Risk Ratio</th>
<th>Weight</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n/N</td>
<td>n/N</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M-H, Random, 95% CI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rempel 2006</td>
<td>14/44</td>
<td>21/44</td>
<td>72.6 %</td>
<td>0.67</td>
<td>[0.39, 1.13]</td>
</tr>
<tr>
<td>Conlon 2008</td>
<td>7/51</td>
<td>11/52</td>
<td>27.4 %</td>
<td>0.65</td>
<td>[0.27, 1.54]</td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>95</strong></td>
<td><strong>96</strong></td>
<td><strong>100.0 %</strong></td>
<td><strong>0.66</strong></td>
<td>[0.42, 1.04]</td>
</tr>
</tbody>
</table>

Total events: 21 (Alternative mouse), 32 (Conventional mouse)
Heterogeneity: Tau² = 0.00; Chi² = 0.00, df = 1 (P = 0.96); I² = 0.0%
Test for overall effect: Z = 1.79 (P = 0.074)
Test for subgroup differences: Not applicable
### Analysis 1.4. Comparison 1 An arm support together with an alternative mouse versus a conventional mouse alone, Outcome 4 Neck/shoulder discomfort score.

Review: Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

Comparison: 1 An arm support together with an alternative mouse versus a conventional mouse alone

Outcome: 4 Neck/shoulder discomfort score

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Experimental</th>
<th>Control</th>
<th>Std. Mean Difference</th>
<th>Weight</th>
<th>Std. Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean(SD)</td>
<td>N</td>
<td>Mean(SD)</td>
<td>IV, Random, 95% CI</td>
</tr>
<tr>
<td>Rempel 2006</td>
<td>45</td>
<td>1.1 (1.3)</td>
<td>46</td>
<td>1.8 (1.9)</td>
<td></td>
</tr>
<tr>
<td>Conlon 2008</td>
<td>51</td>
<td>-1.2 (1.47)</td>
<td>52</td>
<td>-0.66 (1.29)</td>
<td></td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>96</strong></td>
<td></td>
<td><strong>98</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: Tau² = 0.0; Chi² = 0.02, df = 1 (P = 0.90); I² = 0.0%

Test for overall effect: Z = 2.79 (P = 0.0052)

Test for subgroup differences: Not applicable

---

### Analysis 1.5. Comparison 1 An arm support together with an alternative mouse versus a conventional mouse alone, Outcome 5 Right upper extremity discomfort score.

Review: Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

Comparison: 1 An arm support together with an alternative mouse versus a conventional mouse alone

Outcome: 5 Right upper extremity discomfort score

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Experimental</th>
<th>Control</th>
<th>Std. Mean Difference</th>
<th>Weight</th>
<th>Std. Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean(SD)</td>
<td>N</td>
<td>Mean(SD)</td>
<td>IV, Random, 95% CI</td>
</tr>
<tr>
<td>Rempel 2006</td>
<td>45</td>
<td>1.3 (1.8)</td>
<td>46</td>
<td>1.9 (2.1)</td>
<td></td>
</tr>
<tr>
<td>Conlon 2008</td>
<td>51</td>
<td>-1.4 (1.92)</td>
<td>52</td>
<td>-0.77 (1.37)</td>
<td></td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>96</strong></td>
<td></td>
<td><strong>98</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: Tau² = 0.0; Chi² = 0.06, df = 1 (P = 0.80); I² = 0.0%

Test for overall effect: Z = 2.36 (P = 0.018)

Test for subgroup differences: Not applicable
Analysis 2.1. Comparison 2 An alternative mouse alone versus a conventional mouse alone, Outcome 1 Incidence of neck/shoulder disorder.

Review: Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

Comparison: 2 An alternative mouse alone versus a conventional mouse alone

Outcome: 1 Incidence of neck/shoulder disorder

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Alternative mouse</th>
<th>Conventional mouse</th>
<th>Risk Ratio M-H, Random, 95% CI</th>
<th>Weight</th>
<th>Risk Ratio M-H, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rempel 2006</td>
<td>6/35</td>
<td>19/43</td>
<td>62.4 % 0.39 [0.17, 0.87]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conlon 2008</td>
<td>4/52</td>
<td>3/52</td>
<td>37.6 % 1.33 [0.31, 5.67]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>87</td>
<td>95</td>
<td>100.0 % 0.62 [0.19, 2.00]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total events: 10 (Alternative Mouse), 22 (Conventional Mouse)
Heterogeneity: Tau² = 0.41; Chi² = 2.14, df = 1 (P = 0.14); I² = 53%
Test for overall effect: Z = 0.81 (P = 0.42)
Test for subgroup differences: Not applicable

Analysis 2.2. Comparison 2 An alternative mouse alone versus a conventional mouse alone, Outcome 2 Incidence of right upper extremity disorder.

Review: Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

Comparison: 2 An alternative mouse alone versus a conventional mouse alone

Outcome: 2 Incidence of right upper extremity disorder

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Alternative Mouse</th>
<th>Conventional Mouse</th>
<th>Risk Ratio M-H, Random, 95% CI</th>
<th>Weight</th>
<th>Risk Ratio M-H, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rempel 2006</td>
<td>8/38</td>
<td>7/40</td>
<td>48.6 % 1.20 [0.48, 2.99]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conlon 2008</td>
<td>7/52</td>
<td>10/52</td>
<td>51.4 % 0.70 [0.29, 1.70]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>90</td>
<td>92</td>
<td>100.0 % 0.91 [0.48, 1.72]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total events: 15 (Alternative Mouse), 17 (Conventional Mouse)
Heterogeneity: Tau² = 0.0; Chi² = 0.70, df = 1 (P = 0.40); I² = 0.0%
Test for overall effect: Z = 0.29 (P = 0.77)
Test for subgroup differences: Not applicable
**Analysis 2.3. Comparison 2 An alternative mouse alone versus a conventional mouse alone, Outcome 3 Incidence of upper body disorder (neck, shoulder, and upper extremity).**

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Alternative mouse</th>
<th>Conventional mouse</th>
<th>Risk Ratio M,Random,95% CI</th>
<th>Weight</th>
<th>Risk Ratio M,Random,95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rempel 2006</td>
<td>15/42</td>
<td>21/44</td>
<td></td>
<td>69.2 %</td>
<td>0.75 [0.45, 1.25]</td>
</tr>
<tr>
<td>Conlon 2008</td>
<td>10/52</td>
<td>11/52</td>
<td></td>
<td>30.8 %</td>
<td>0.91 [0.42, 1.95]</td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>94</strong></td>
<td><strong>96</strong></td>
<td></td>
<td><strong>100.0 %</strong></td>
<td><strong>0.79 [0.52, 1.21]</strong></td>
</tr>
</tbody>
</table>

Total events: 25 (Alternative mouse), 32 (Conventional mouse)
Heterogeneity: Tau² = 0.0; Chi² = 0.18; df = 1 (P = 0.68); I² = 0.0%
Test for overall effect: Z = 1.06 (P = 0.29)
Test for subgroup differences: Not applicable

---

**Analysis 2.4. Comparison 2 An alternative mouse alone versus a conventional mouse alone, Outcome 4 Neck/shoulder discomfort score.**

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Alternative Mouse</th>
<th>Conventional Mouse</th>
<th>Std. Mean Difference IV,Random,95% CI</th>
<th>Weight</th>
<th>Std. Mean Difference IV,Random,95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rempel 2006</td>
<td>45 2.2 (2.2)</td>
<td>46 1.8 (1.9)</td>
<td></td>
<td>46.8 %</td>
<td>0.19 [-0.22, 0.61]</td>
</tr>
<tr>
<td>Conlon 2008</td>
<td>52 -0.81 (1.56)</td>
<td>52 -0.66 (1.29)</td>
<td></td>
<td>53.2 %</td>
<td>-0.10 [-0.49, 0.28]</td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>97</strong></td>
<td><strong>98</strong></td>
<td></td>
<td><strong>100.0 %</strong></td>
<td><strong>0.04 [-0.26, 0.33]</strong></td>
</tr>
</tbody>
</table>

Heterogeneity: Tau² = 0.00; Chi² = 1.07; df = 1 (P = 0.30); I² = 6%
Test for overall effect: Z = 0.24 (P = 0.81)
Test for subgroup differences: Not applicable

---

Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults (Review)

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**Analysis 2.5. Comparison 2 An alternative mouse alone versus a conventional mouse alone, Outcome 5 Right upper extremity discomfort score.**

**Review:** Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

**Comparison:** 2 An alternative mouse alone versus a conventional mouse alone

**Outcome:** 5 Right upper extremity discomfort score

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Alternative Mouse</th>
<th>Conventional Mouse</th>
<th>Std. Mean Difference</th>
<th>Weight</th>
<th>Std. Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean(SD)</td>
<td>N</td>
<td>Mean(SD)</td>
<td>IV,Random,95% CI</td>
</tr>
<tr>
<td>Rempel 2006</td>
<td>45</td>
<td>1.9 (1.8)</td>
<td>46</td>
<td>1.9 (2.1)</td>
<td>46.7 %</td>
</tr>
<tr>
<td>Conlon 2008</td>
<td>52</td>
<td>-0.76 (1.13)</td>
<td>52</td>
<td>-0.77 (1.37)</td>
<td>53.3 %</td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td>97</td>
<td>98</td>
<td>100.0 %</td>
<td>0.00 [ -0.28, 0.28 ]</td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: Tau² = 0.0; Chi² = 0.00, df = 1 (P = 0.98); I² =0.0%
Test for overall effect: Z = 0.03 (P = 0.98)
Test for subgroup differences: Not applicable

---

**Analysis 3.1. Comparison 3 An arm support together with a conventional mouse versus a conventional mouse alone, Outcome 1 Incidence of neck/shoulder disorder.**

**Review:** Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

**Comparison:** 3 An arm support together with a conventional mouse versus a conventional mouse alone

**Outcome:** 1 Incidence of neck/shoulder disorder

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Arm support board</th>
<th>No arm support board</th>
<th>Risk Ratio</th>
<th>Weight</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n/N</td>
<td>n/N</td>
<td>M-H,Fixed,95% CI</td>
<td>M-H,Fixed,95% CI</td>
<td></td>
</tr>
<tr>
<td>Rempel 2006</td>
<td>6/40</td>
<td>19/43</td>
<td>86.0 %</td>
<td>0.34 [ 0.15, 0.76 ]</td>
<td></td>
</tr>
<tr>
<td>Conlon 2008</td>
<td>8/51</td>
<td>3/52</td>
<td>14.0 %</td>
<td>2.72 [ 0.76, 9.68 ]</td>
<td></td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td>91</td>
<td>95</td>
<td>100.0 %</td>
<td>0.67 [ 0.36, 1.24 ]</td>
<td></td>
</tr>
</tbody>
</table>

Total events: 14 (Arm support board), 22 (No arm support board)
Heterogeneity: Chi² = 7.38, df = 1 (P = 0.01); I² =86%
Test for overall effect: Z = 1.28 (P = 0.20)
Test for subgroup differences: Not applicable
Analysis 3.2. Comparison 3 An arm support together with a conventional mouse versus a conventional mouse alone, Outcome 2 Incidence of right upper extremity disorders.

Review: Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

Comparison: 3 An arm support together with a conventional mouse versus a conventional mouse alone

Outcome: 2 Incidence of right upper extremity disorders

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Arm support board</th>
<th>No arm support board</th>
<th>Odds Ratio M-H, Random, 95% CI</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conlon 2008</td>
<td>10/51</td>
<td>10/52</td>
<td>58.6% 1.02 [0.39, 2.72]</td>
<td></td>
</tr>
<tr>
<td>Rempel 2006</td>
<td>7/35</td>
<td>7/40</td>
<td>41.4% 1.18 [0.37, 3.77]</td>
<td></td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>86</strong></td>
<td><strong>92</strong></td>
<td><strong>100.0% 1.09 [0.51, 2.29]</strong></td>
<td></td>
</tr>
</tbody>
</table>

Total events: 17 (Arm support board), 17 (No arm support board)
Heterogeneity: Tau^2 = 0.0; Chi^2 = 0.03, df = 1 (P = 0.86); I^2 = 0.0%
Test for overall effect: Z = 0.22 (P = 0.83)
Test for subgroup differences: Not applicable

Analysis 3.3. Comparison 3 An arm support together with a conventional mouse versus a conventional mouse alone, Outcome 3 Incidence of upper body disorders.

Review: Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

Comparison: 3 An arm support together with a conventional mouse versus a conventional mouse alone

Outcome: 3 Incidence of upper body disorders

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Arm support board</th>
<th>No arm support board</th>
<th>Risk Ratio M-H, Random, 95% CI</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rempel 2006</td>
<td>13/44</td>
<td>21/44</td>
<td>54.0% 0.62 [0.36, 1.07]</td>
<td></td>
</tr>
<tr>
<td>Conlon 2008</td>
<td>14/51</td>
<td>11/52</td>
<td>46.0% 1.30 [0.65, 2.58]</td>
<td></td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>95</strong></td>
<td><strong>96</strong></td>
<td><strong>100.0% 0.87 [0.42, 1.80]</strong></td>
<td></td>
</tr>
</tbody>
</table>

Total events: 27 (Arm support board), 32 (No arm support board)
Heterogeneity: Tau^2 = 0.17; Chi^2 = 2.72, df = 1 (P = 0.10); I^2 = 63%
Test for overall effect: Z = 0.38 (P = 0.71)
Test for subgroup differences: Not applicable
**Analysis 3.4. Comparison 3 An arm support together with a conventional mouse versus a conventional mouse alone, Outcome 4 Neck/shoulder discomfort score.**

Review: Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

Comparison: 3 An arm support together with a conventional mouse versus a conventional mouse alone

Outcome: 4 Neck/shoulder discomfort score

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Arm support board</th>
<th>No arm support board</th>
<th>Std. Mean Difference</th>
<th>Weight</th>
<th>Std. Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rempel 2006</td>
<td>46</td>
<td>46</td>
<td>1.8 (2.1)</td>
<td>47.2 %</td>
<td>0.0 [-0.41, 0.41]</td>
</tr>
<tr>
<td>Conlon 2008</td>
<td>51</td>
<td>52</td>
<td>-0.61 (1.64)</td>
<td>52.8 %</td>
<td>0.03 [-0.35, 0.42]</td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>97</strong></td>
<td><strong>98</strong></td>
<td></td>
<td><strong>100.0 %</strong></td>
<td><strong>0.02 [-0.26, 0.30]</strong></td>
</tr>
</tbody>
</table>

Heterogeneity: Tau^2 = 0.0; Ch\(^2\) = 0.01, df = 1 (P = 0.91); I^2 =0.0%

Test for overall effect: Z = 0.12 (P = 0.90)

Test for subgroup differences: Not applicable

---

**Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults (Review)**

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### Analysis 3.5. Comparison 3 An arm support together with a conventional mouse versus a conventional mouse alone, Outcome 5 Right upper extremity discomfort score.

**Review:** Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

**Comparison:** 3 An arm support together with a conventional mouse versus a conventional mouse alone

**Outcome:** 5 Right upper extremity discomfort score

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Arm support board</th>
<th>No arm support board</th>
<th>Std. Mean Difference</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean(SD)</td>
<td>N</td>
<td>Mean(SD)</td>
</tr>
<tr>
<td>Rempel 2006</td>
<td>46</td>
<td>1.7 (2.2)</td>
<td>46</td>
<td>1.9 (2.1)</td>
</tr>
<tr>
<td>Conlon 2008</td>
<td>51</td>
<td>-0.83 (1.45)</td>
<td>52</td>
<td>-0.77 (1.37)</td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td>97</td>
<td>100.0 %</td>
<td>98</td>
<td>-0.07 [-0.35, 0.22]</td>
</tr>
</tbody>
</table>

Heterogeneity: Tau² = 0.0; Chi² = 0.03, df = 1 (P = 0.86); I² = 0%
Test for overall effect: Z = 0.46 (P = 0.65)
Test for subgroup differences: Not applicable

### Analysis 4.1. Comparison 4 An alternative mouse with an arm support versus a conventional mouse with an arm support, Outcome 1 Incidence of neck/shoulder disorder.

**Review:** Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

**Comparison:** 4 An alternative mouse with an arm support versus a conventional mouse with an arm support

**Outcome:** 1 Incidence of neck/shoulder disorder

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Alternative mouse</th>
<th>Conventional mouse</th>
<th>Risk Ratio M- M-</th>
<th>Weight</th>
<th>Risk Ratio M- M-</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n/N</td>
<td>n/N</td>
<td>M- H,Random,95% CI</td>
<td></td>
<td>M- H,Random,95% CI</td>
</tr>
<tr>
<td>Rempel 2006</td>
<td>8/40</td>
<td>6/40</td>
<td>1.33 [0.51, 3.49]</td>
<td>55.5 %</td>
<td>1.33 [0.51, 3.49]</td>
</tr>
<tr>
<td>Conlon 2008</td>
<td>3/51</td>
<td>8/51</td>
<td>0.38 [0.11, 1.33]</td>
<td>44.5 %</td>
<td>0.38 [0.11, 1.33]</td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td>91</td>
<td>91</td>
<td>0.76 [0.22, 2.63]</td>
<td>100.0 %</td>
<td>0.76 [0.22, 2.63]</td>
</tr>
</tbody>
</table>

Total events: 11 (Alternative mouse), 14 (Conventional mouse)
Heterogeneity: Tau² = 0.48; Chi² = 2.46, df = 1 (P = 0.12); I² = 59%
Test for overall effect: Z = 0.44 (P = 0.66)
Test for subgroup differences: Not applicable

---

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### Analysis 4.2. Comparison 4 An alternative mouse with an arm support versus a conventional mouse with an arm support, Outcome 2 Incidence of right upper limb disorder.

**Review:** Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

**Comparison:** 4 An alternative mouse with an arm support versus a conventional mouse with an arm support

**Outcome:** 2 Incidence of right upper limb disorder

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Alternative mouse</th>
<th>Conventional mouse</th>
<th>Risk Ratio</th>
<th>Weight</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n/N</td>
<td>n/N</td>
<td>M-H, Random, 95% CI</td>
<td></td>
<td>M-H, Random, 95% CI</td>
</tr>
<tr>
<td>Rempel 2006</td>
<td>7/38</td>
<td>7/35</td>
<td>60.5 %</td>
<td>0.92 [0.36, 2.36]</td>
<td></td>
</tr>
<tr>
<td>Conlon 2008</td>
<td>4/51</td>
<td>7/51</td>
<td>39.5 %</td>
<td>0.57 [0.18, 1.83]</td>
<td></td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>89</strong></td>
<td><strong>86</strong></td>
<td><strong>100.0 %</strong></td>
<td><strong>0.76 [0.37, 1.59]</strong></td>
<td></td>
</tr>
</tbody>
</table>

Total events: 11 (Alternative mouse), 14 (Conventional mouse)

Heterogeneity: Tau² = 0.0; Chi² = 0.39, df = 1 (P = 0.53); I² = 0.0%

Test for overall effect: Z = 0.72 (P = 0.47)

Test for subgroup differences: Not applicable

### Analysis 4.3. Comparison 4 An alternative mouse with an arm support versus a conventional mouse with an arm support, Outcome 3 Incidence of upper body disorders (neck, shoulder, and upper limb).

**Review:** Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

**Comparison:** 4 An alternative mouse with an arm support versus a conventional mouse with an arm support

**Outcome:** 3 Incidence of upper body disorders (neck, shoulder, and upper limb)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Alternative mouse</th>
<th>Conventional mouse</th>
<th>Risk Ratio</th>
<th>Weight</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n/N</td>
<td>n/N</td>
<td>M-H, Random, 95% CI</td>
<td></td>
<td>M-H, Random, 95% CI</td>
</tr>
<tr>
<td>Rempel 2006</td>
<td>14/44</td>
<td>13/44</td>
<td>56.1 %</td>
<td>1.08 [0.57, 2.02]</td>
<td></td>
</tr>
<tr>
<td>Conlon 2008</td>
<td>7/51</td>
<td>14/51</td>
<td>43.9 %</td>
<td>0.50 [0.22, 1.14]</td>
<td></td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>95</strong></td>
<td><strong>95</strong></td>
<td><strong>100.0 %</strong></td>
<td><strong>0.77 [0.36, 1.63]</strong></td>
<td></td>
</tr>
</tbody>
</table>

Total events: 21 (Alternative mouse), 27 (Conventional mouse)

Heterogeneity: Tau² = 0.16; Chi² = 2.14, df = 1 (P = 0.14); I² = 53%

Test for overall effect: Z = 0.69 (P = 0.49)

Test for subgroup differences: Not applicable

---

Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults (Review)

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Analysis 4.4. Comparison 4 An alternative mouse with an arm support versus a conventional mouse with an arm support, Outcome 4 Neck/shoulder discomfort score.

Review: Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

Comparison: 4 An alternative mouse with an arm support versus a conventional mouse with an arm support

Outcome: 4 Neck/shoulder discomfort score

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Alternative mouse</th>
<th>Conventional mouse</th>
<th>Std. Mean Difference</th>
<th>Weight</th>
<th>Std. Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rempel 2006</td>
<td>45</td>
<td>46</td>
<td>-0.40</td>
<td>47.1%</td>
<td>-0.40 [ -0.81, 0.02 ]</td>
</tr>
<tr>
<td>Conlon 2008</td>
<td>51</td>
<td>51</td>
<td>-0.38</td>
<td>52.9%</td>
<td>-0.38 [ -0.77, 0.02 ]</td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>96</td>
<td>97</td>
<td>100.0% -0.39 [ -0.67, -0.10 ]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: Tau² = 0.0; Chi² = 0.00, df = 1 (P = 0.94); I² = 0.0%
Test for overall effect: Z = 2.65 (P = 0.0080)
Test for subgroup differences: Not applicable

Analysis 4.5. Comparison 4 An alternative mouse with an arm support versus a conventional mouse with an arm support, Outcome 5 Right upper extremity discomfort score.

Review: Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

Comparison: 4 An alternative mouse with an arm support versus a conventional mouse with an arm support

Outcome: 5 Right upper extremity discomfort score

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Alternative mouse</th>
<th>Conventional mouse</th>
<th>Std. Mean Difference</th>
<th>Weight</th>
<th>Std. Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rempel 2006</td>
<td>45</td>
<td>46</td>
<td>-0.20</td>
<td>47.4%</td>
<td>-0.20 [ -0.61, 0.21 ]</td>
</tr>
<tr>
<td>Conlon 2008</td>
<td>51</td>
<td>51</td>
<td>-0.33</td>
<td>52.6%</td>
<td>-0.33 [ -0.72, 0.06 ]</td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>96</td>
<td>97</td>
<td>100.0% -0.27 [ -0.55, 0.02 ]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: Tau² = 0.0; Chi² = 0.22, df = 1 (P = 0.64); I² = 0.0%
Test for overall effect: Z = 1.85 (P = 0.064)
Test for subgroup differences: Not applicable

Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults (Review)  
Copyright © 2012 The Cochrane Collaboration. Published by John Wiley & Sons, Ltd.
Analysis 5.1. Comparison 5 Supplementary breaks versus normal breaks, Outcome 1 After shifts discomfort rating for neck (4-8 weeks).

Review: Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

Comparison: 5 Supplementary breaks versus normal breaks

Outcome: 1 After shifts discomfort rating for neck (4-8 weeks)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Reduced hours group</th>
<th>Reference group</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean (SD)</td>
<td>N</td>
<td>Mean (SD)</td>
<td>IV, Fixed, 95% CI</td>
</tr>
<tr>
<td>Galinsky 2000</td>
<td>42</td>
<td>1.9 (0.85)</td>
<td>42</td>
<td>2.23 (0.97)</td>
<td>49.6%</td>
</tr>
<tr>
<td>Galinsky 2007</td>
<td>51</td>
<td>1.77 (0.93)</td>
<td>51</td>
<td>1.95 (1.06)</td>
<td>50.4%</td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td>93</td>
<td></td>
<td></td>
<td></td>
<td><strong>100.0% -0.25 [-0.53, 0.02]</strong></td>
</tr>
</tbody>
</table>

Heterogeneity: Chi² = 0.29, df = 1 (P = 0.59); I² = 0.0%
Test for overall effect: Z = 1.82 (P = 0.070)
Test for subgroup differences: Not applicable

Analysis 5.2. Comparison 5 Supplementary breaks versus normal breaks, Outcome 2 After shifts discomfort ratings for right shoulder/upper arm (4-8 weeks).

Review: Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

Comparison: 5 Supplementary breaks versus normal breaks

Outcome: 2 After shifts discomfort ratings for right shoulder/upper arm (4-8 weeks)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Reduced hours group</th>
<th>Reference group</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean (SD)</td>
<td>N</td>
<td>Mean (SD)</td>
<td>IV, Random, 95% CI</td>
</tr>
<tr>
<td>Galinsky 2000</td>
<td>42</td>
<td>1.72 (0.76)</td>
<td>42</td>
<td>1.98 (0.94)</td>
<td>55.5%</td>
</tr>
<tr>
<td>Galinsky 2007</td>
<td>51</td>
<td>1.8 (1)</td>
<td>51</td>
<td>2.02 (1.1)</td>
<td>44.5%</td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td>93</td>
<td></td>
<td></td>
<td></td>
<td><strong>100.0% -0.24 [-0.51, 0.03]</strong></td>
</tr>
</tbody>
</table>

Heterogeneity: Tau² = 0.0; Chi² = 0.02, df = 1 (P = 0.89); I² = 0.0%
Test for overall effect: Z = 1.74 (P = 0.081)
Test for subgroup differences: Not applicable
Analysis 5.3. Comparison 5 Supplementary breaks versus normal breaks, Outcome 3 After shifts discomfort ratings for right forearm/wrist/hand (4-8 weeks).

Review: Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

Comparison: 5 Supplementary breaks versus normal breaks

Outcome: 3 After shifts discomfort ratings for right forearm/wrist/hand (4-8 weeks)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Reduced hours group</th>
<th>Reference group</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean(SD)</td>
<td>N</td>
<td>Mean(SD)</td>
<td>IV,Random,95% CI</td>
</tr>
<tr>
<td></td>
<td>42</td>
<td>1.74 (0.82)</td>
<td>42</td>
<td>1.98 (0.93)</td>
<td>50.1 %</td>
</tr>
<tr>
<td>Galinsky 2000</td>
<td>51</td>
<td>1.82 (0.9)</td>
<td>51</td>
<td>1.95 (1.03)</td>
<td>49.9 %</td>
</tr>
<tr>
<td></td>
<td>93</td>
<td>100.0 %</td>
<td>-0.19 [ -0.45, 0.08 ]</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>93</td>
<td>100.0 %</td>
<td>-0.19 [ -0.45, 0.08 ]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: Tau^2 = 0.0; Chi^2 = 0.17, df = 1 (P = 0.68); I^2 =0.0%

Test for overall effect: Z = 1.37 (P = 0.17)

Test for subgroup differences: Not applicable

Analysis 6.1. Comparison 6 Reduce work hours versus normal work hours, Outcome 1 Upper extremity disorder (6 months).

Review: Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

Comparison: 6 Reduce work hours versus normal work hours

Outcome: 1 Upper extremity disorder (6 months)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Reduced hours group</th>
<th>Reference group</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean(SD)</td>
<td>N</td>
<td>Mean(SD)</td>
<td>IV,Fixed,95% CI</td>
</tr>
<tr>
<td></td>
<td>43</td>
<td>1.98 (1.06)</td>
<td>59</td>
<td>1.9 (0.94)</td>
<td>100.0 %</td>
</tr>
<tr>
<td>von Thiele 2008</td>
<td>59</td>
<td>1.9 (0.94)</td>
<td>100.0 %</td>
<td>0.08 [ -0.32, 0.48 ]</td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: not applicable

Test for overall effect: Z = 0.39 (P = 0.69)

Test for subgroup differences: Not applicable
### Analysis 6.2. Comparison 6 Reduce work hours versus normal work hours, Outcome 2 Upper extremity disorder (12 months).

**Review:** Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

**Comparison:** 6 Reduce work hours versus normal work hours

**Outcome:** 2 Upper extremity disorder (12 months)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Reduced hours group</th>
<th>Reference group</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean(SD)(mean score)</td>
<td>N</td>
<td>Mean(SD)(mean score)</td>
<td>IV,Random,95% CI</td>
</tr>
<tr>
<td>von Thiele 2008</td>
<td>43</td>
<td>1.93 (1.14)</td>
<td>59</td>
<td>1.71 (1.08)</td>
<td>100.0 % 0.22 [-0.22, 0.66]</td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td>43</td>
<td>59</td>
<td>100.0 % 0.22 [-0.22, 0.66]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: not applicable

Test for overall effect: Z = 0.98 (P = 0.33)

Test for subgroup differences: Not applicable

### Analysis 6.3. Comparison 6 Reduce work hours versus normal work hours, Outcome 3 Work ability (6 months).

**Review:** Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

**Comparison:** 6 Reduce work hours versus normal work hours

**Outcome:** 3 Work ability (6 months)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Reduced hours group</th>
<th>Reference group</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean(SD)</td>
<td>N</td>
<td>Mean(SD)</td>
<td>IV,Fixed,95% CI</td>
</tr>
<tr>
<td>von Thiele 2008</td>
<td>45</td>
<td>8.31 (1.54)</td>
<td>59</td>
<td>7.9 (2.03)</td>
<td>100.0 % 0.41 [-0.28, 1.10]</td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td>45</td>
<td>59</td>
<td>100.0 % 0.41 [-0.28, 1.10]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: not applicable

Test for overall effect: Z = 1.17 (P = 0.24)

Test for subgroup differences: Not applicable
### Analysis 6.4. Comparison 6 Reduce work hours versus normal work hours, Outcome 4 Work ability (12 months).

Review: Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

Comparison: 6 Reduce work hours versus normal work hours

Outcome: 4 Work ability (12 months)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Reduced hours group</th>
<th>Reference group</th>
<th>Mean Difference</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean(SD)</td>
<td>N</td>
<td>Mean(SD)</td>
</tr>
<tr>
<td>von Thiele 2008</td>
<td>45</td>
<td>8.09 (1.52)</td>
<td>59</td>
<td>7.59 (2.27)</td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>45</td>
<td>59</td>
<td>100.0 % 0.50 [ -0.23, 1.23 ]</td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: not applicable

Test for overall effect: Z = 1.34 (P = 0.18)

Test for subgroup differences: Not applicable

### Analysis 7.1. Comparison 7 Ergonomic training versus no intervention, Outcome 1 Neck/shoulder musculoskeletal symptoms by medical examination.

Review: Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

Comparison: 7 Ergonomic training versus no intervention

Outcome: 1 Neck/shoulder musculoskeletal symptoms by medical examination

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Experimental</th>
<th>Control</th>
<th>Risk Ratio</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n/N</td>
<td>n/N</td>
<td>M-H,Fixed,95% CI</td>
<td>100.0 % 1.19 [ 0.66, 2.14 ]</td>
</tr>
<tr>
<td>Brison 1999</td>
<td>19/210</td>
<td>22/289</td>
<td>1.19 [ 0.66, 2.14 ]</td>
<td></td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>210</td>
<td>289</td>
<td>100.0 % 1.19 [ 0.66, 2.14 ]</td>
<td></td>
</tr>
</tbody>
</table>

Total events: 19 (Experimental), 22 (Control)

Heterogeneity: not applicable

Test for overall effect: Z = 0.58 (P = 0.56)

Test for subgroup differences: Not applicable
**Analysis 7.2. Comparison 7 Ergonomic training versus no intervention, Outcome 2 Hand/wrist symptoms by medical examination.**

Review: Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

Comparison: 7 Ergonomic training versus no intervention

Outcome: 2 Hand/wrist symptoms by medical examination

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Experimental</th>
<th>Control</th>
<th>Risk Ratio</th>
<th>Weight</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n/N</td>
<td>n/N</td>
<td>M-H,Fixed,95% CI</td>
<td></td>
<td>M-H,Fixed,95% CI</td>
</tr>
<tr>
<td>Brisson 1999</td>
<td>5/213</td>
<td>5/296</td>
<td>100.0 %</td>
<td>1.39 [ 0.41, 4.74 ]</td>
<td>1.39 [ 0.41, 4.74 ]</td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>213</strong></td>
<td><strong>296</strong></td>
<td><strong>100.0 %</strong></td>
<td><strong>1.39 [ 0.41, 4.74 ]</strong></td>
<td><strong>1.39 [ 0.41, 4.74 ]</strong></td>
</tr>
</tbody>
</table>

Total events: 5 (Experimental), 5 (Control)
Heterogeneity: not applicable
Test for overall effect: Z = 0.53 (P = 0.60)
Test for subgroup differences: Not applicable

**Analysis 7.3. Comparison 7 Ergonomic training versus no intervention, Outcome 3 Intensity of upper extremity pain.**

Review: Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

Comparison: 7 Ergonomic training versus no intervention

Outcome: 3 Intensity of upper extremity pain

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Experimental</th>
<th>Control</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N Mean(SD)</td>
<td>N Mean(SD)</td>
<td>IV,Fixed,95% CI</td>
<td></td>
<td>IV,Fixed,95% CI</td>
</tr>
<tr>
<td>Greene 2005</td>
<td>40 0.67 (0.74)</td>
<td>42 0.59 (0.63)</td>
<td>100.0 %</td>
<td>0.08 [-0.22, 0.38 ]</td>
<td></td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>40</strong></td>
<td><strong>42</strong></td>
<td><strong>100.0 %</strong></td>
<td><strong>0.08 [-0.22, 0.38 ]</strong></td>
<td><strong>0.08 [-0.22, 0.38 ]</strong></td>
</tr>
</tbody>
</table>

Heterogeneity: not applicable
Test for overall effect: Z = 0.53 (P = 0.60)
Test for subgroup differences: Not applicable
Analysis 7.4. Comparison 7 Ergonomic training versus no intervention, Outcome 4 Frequency of upper extremity pain.

Review: Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

Comparison: 7 Ergonomic training versus no intervention

Outcome: 4 Frequency of upper extremity pain

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Experimental</th>
<th>Control</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N Mean(SD)</td>
<td>N Mean(SD)</td>
<td>IV/Fixed,95% CI</td>
<td></td>
<td>IV/Fixed,95% CI</td>
</tr>
<tr>
<td>Greene 2005</td>
<td>40 0.87 (0.96)</td>
<td>42 0.9 (0.98)</td>
<td>100.0 %</td>
<td>-0.03 [ -0.45, 0.39 ]</td>
<td></td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>40 0.87 (0.96)</td>
<td>42 0.9 (0.98)</td>
<td>100.0 %</td>
<td>-0.03 [ -0.45, 0.39 ]</td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: not applicable
Test for overall effect: $Z = 0.14$ ($P = 0.89$)
Test for subgroup differences: Not applicable

Analysis 7.5. Comparison 7 Ergonomic training versus no intervention, Outcome 5 Duration of upper extremity pain.

Review: Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

Comparison: 7 Ergonomic training versus no intervention

Outcome: 5 Duration of upper extremity pain

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Experimental</th>
<th>Control</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N Mean(SD)</td>
<td>N Mean(SD)</td>
<td>IV/Fixed,95% CI</td>
<td></td>
<td>IV/Fixed,95% CI</td>
</tr>
<tr>
<td>Greene 2005</td>
<td>40 0.86 (0.98)</td>
<td>42 0.73 (0.75)</td>
<td>100.0 %</td>
<td>0.13 [ -0.25, 0.51 ]</td>
<td></td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>40 0.86 (0.98)</td>
<td>42 0.73 (0.75)</td>
<td>100.0 %</td>
<td>0.13 [ -0.25, 0.51 ]</td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: not applicable
Test for overall effect: $Z = 0.67$ ($P = 0.50$)
Test for subgroup differences: Not applicable
### Analysis 8.1. Comparison 8 Work injury prevention programme versus no intervention, Outcome 1
Frequency of neck ache or pain.

Review: Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

Comparison: 8 Work injury prevention programme versus no intervention

Outcome: 1 Frequency of neck ache or pain

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Experimental</th>
<th>Control</th>
<th>Mean(SD)</th>
<th>Mean(SD)</th>
<th>Mean Difference IV/Fixed,95% CI</th>
<th>Weight</th>
<th>Mean Difference IV/Fixed,95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gatty 2004</td>
<td>6</td>
<td>7</td>
<td>0.8 (0.98)</td>
<td>2 (1.83)</td>
<td>-1.20 [-2.77, 0.37]</td>
<td>100.0%</td>
<td>-1.20 [-2.77, 0.37]</td>
</tr>
</tbody>
</table>

Total (95% CI) 6 7 100.0% -1.20 [-2.77, 0.37]

Heterogeneity: not applicable

Test for overall effect: Z = 1.50 (P = 0.13)

Test for subgroup differences: Not applicable

### Analysis 8.2. Comparison 8 Work injury prevention programme versus no intervention, Outcome 2
Frequency of shoulder ache or pain.

Review: Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

Comparison: 8 Work injury prevention programme versus no intervention

Outcome: 2 Frequency of shoulder ache or pain

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Experimental</th>
<th>Control</th>
<th>Mean(SD)</th>
<th>Mean(SD)</th>
<th>Mean Difference IV/Fixed,95% CI</th>
<th>Weight</th>
<th>Mean Difference IV/Fixed,95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gatty 2004</td>
<td>6</td>
<td>7</td>
<td>0.6 (0.82)</td>
<td>1.7 (1.89)</td>
<td>-1.10 [-2.65, 0.45]</td>
<td>100.0%</td>
<td>-1.10 [-2.65, 0.45]</td>
</tr>
</tbody>
</table>

Total (95% CI) 6 7 100.0% -1.10 [-2.65, 0.45]

Heterogeneity: not applicable

Test for overall effect: Z = 1.39 (P = 0.16)

Test for subgroup differences: Not applicable
### Analysis 8.3. Comparison 8 Work injury prevention programme versus no intervention, Outcome 3
Frequency of wrist/hand ache or pain.

**Review:** Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

**Comparison:** Work injury prevention programme versus no intervention

**Outcome:** 3 Frequency of wrist/hand ache or pain

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Experimental</th>
<th>Control</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study or subgroup</td>
<td>N  Mean(SD)</td>
<td>N  Mean(SD)</td>
<td>IV,Fixed,95% CI</td>
<td>IV,Fixed,95% CI</td>
<td></td>
</tr>
<tr>
<td>Gatty 2004</td>
<td>6  0.3 (0.52)</td>
<td>7  1.3 (1.98)</td>
<td></td>
<td>-1.00 [ -2.52, 0.52 ]</td>
<td></td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td>6  7</td>
<td>100.0 %</td>
<td>-1.00 [ -2.52, 0.52 ]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: not applicable

Test for overall effect: Z = 1.29 (P = 0.20)

Test for subgroup differences: Not applicable

---

### Analysis 8.4. Comparison 8 Work injury prevention programme versus no intervention, Outcome 4
Intensity of neck ache or pain.

**Review:** Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

**Comparison:** Work injury prevention programme versus no intervention

**Outcome:** 4 Intensity of neck ache or pain

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Experimental</th>
<th>Control</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study or subgroup</td>
<td>N  Mean(SD)</td>
<td>N  Mean(SD)</td>
<td>IV,Fixed,95% CI</td>
<td>IV,Fixed,95% CI</td>
<td></td>
</tr>
<tr>
<td>Gatty 2004</td>
<td>6  1.7 (0.82)</td>
<td>7  2 (0.82)</td>
<td></td>
<td>-0.30 [ -1.19, 0.59 ]</td>
<td></td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td>6  7</td>
<td>100.0 %</td>
<td>-0.30 [ -1.19, 0.59 ]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: not applicable

Test for overall effect: Z = 0.66 (P = 0.51)

Test for subgroup differences: Not applicable
### Analysis 8.5. Comparison 8 Work injury prevention programme versus no intervention, Outcome 5
Intensity of shoulder ache or pain.

**Review:** Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

**Comparison:** Work injury prevention programme versus no intervention

**Outcome:** 5 Intensity of shoulder ache or pain

<table>
<thead>
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<th>Study or subgroup</th>
<th>Experimental</th>
<th>Control</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
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</thead>
<tbody>
<tr>
<td>N</td>
<td>Mean(SD)</td>
<td>N</td>
<td>Mean(SD)</td>
<td>IV/Fixed,95% CI</td>
<td>IV/Fixed,95% CI</td>
</tr>
<tr>
<td>Gatty 2004</td>
<td>6 1.5 (0.55)</td>
<td>7 1.7 (0.76)</td>
<td>-0.20 [-0.91, 0.51]</td>
<td>100.0 %</td>
<td></td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>6</td>
<td>7</td>
<td>100.0 %</td>
<td>-0.20 [-0.91, 0.51]</td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: not applicable

Test for overall effect: Z = 0.55 (P = 0.58)

Test for subgroup differences: Not applicable

### Analysis 8.6. Comparison 8 Work injury prevention programme versus no intervention, Outcome 6
Intensity of wrist/hand ache or pain.

**Review:** Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

**Comparison:** Work injury prevention programme versus no intervention

**Outcome:** 6 Intensity of wrist/hand ache or pain

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Experimental</th>
<th>Control</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
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</thead>
<tbody>
<tr>
<td>N</td>
<td>Mean(SD)</td>
<td>N</td>
<td>Mean(SD)</td>
<td>IV/Fixed,95% CI</td>
<td>IV/Fixed,95% CI</td>
</tr>
<tr>
<td>Gatty 2004</td>
<td>6 1.5 (0.84)</td>
<td>7 1.7 (0.95)</td>
<td>-0.20 [-1.17, 0.77]</td>
<td>100.0 %</td>
<td></td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>6</td>
<td>7</td>
<td>100.0 %</td>
<td>-0.20 [-1.17, 0.77]</td>
<td></td>
</tr>
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</table>

Heterogeneity: not applicable

Test for overall effect: Z = 0.40 (P = 0.69)

Test for subgroup differences: Not applicable
Analysis 9.1. Comparison 9 Patient lifting/transfer intervention versus normal practice, Outcome 1
Shoulder pain (safe lifting versus usual practice).

Review: Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

Comparison: 9 Patient lifting/transfer intervention versus normal practice

Outcome: 1 Shoulder pain (safe lifting versus usual practice)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Experimental</th>
<th>Control</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yassi 2001</td>
<td>85 27.1 (24.9)</td>
<td>81 24.1 (26.5)</td>
<td>3.00 [ -4.83, 10.83 ]</td>
<td>100.0 %</td>
<td>3.00 [ -4.83, 10.83 ]</td>
</tr>
</tbody>
</table>

Total (95% CI) 85 81 100.0 % 3.00 [ -4.83, 10.83 ]

Heterogeneity: not applicable
Test for overall effect: Z = 0.75 (P = 0.45)
Test for subgroup differences: Not applicable

Analysis 9.2. Comparison 9 Patient lifting/transfer intervention versus normal practice, Outcome 2
Shoulder pain (no strenuous lifting versus usual practice).

Review: Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

Comparison: 9 Patient lifting/transfer intervention versus normal practice

Outcome: 2 Shoulder pain (no strenuous lifting versus usual practice)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Experimental</th>
<th>Control</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yassi 2001</td>
<td>94 24.2 (25.4)</td>
<td>81 24.1 (26.5)</td>
<td>0.10 [ -7.62, 7.82 ]</td>
<td>100.0 %</td>
<td>0.10 [ -7.62, 7.82 ]</td>
</tr>
</tbody>
</table>

Total (95% CI) 94 81 100.0 % 0.10 [ -7.62, 7.82 ]

Heterogeneity: not applicable
Test for overall effect: Z = 0.03 (P = 0.98)
Test for subgroup differences: Not applicable
Analysis 9.3. Comparison 9 Patient lifting/transfer intervention versus normal practice, Outcome 3 DASH (no lifting versus usual practice).

Review: Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

Comparison: 9 Patient lifting/transfer intervention versus normal practice

Outcome: 3 DASH (no lifting versus usual practice)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Experimental</th>
<th>Control</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
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<tbody>
<tr>
<td>N</td>
<td>Mean(SD)</td>
<td>N</td>
<td>Mean(SD)</td>
<td>IV,Fixed,95% CI</td>
<td>IV,Fixed,95% CI</td>
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<tr>
<td>Yassi 2001</td>
<td>85</td>
<td>7.3 (10.9)</td>
<td>81</td>
<td>6.3 (10.9)</td>
<td>1.00 [-2.32, 4.32]</td>
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<tr>
<td>Total (95% CI)</td>
<td>85</td>
<td>81</td>
<td>100.0 %</td>
<td>1.00 [-2.32, 4.32]</td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: not applicable

Test for overall effect: Z = 0.59 (P = 0.55)

Test for subgroup differences: Not applicable

Analysis 9.4. Comparison 9 Patient lifting/transfer intervention versus normal practice, Outcome 4 DASH (no strenuous lifting).

Review: Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults

Comparison: 9 Patient lifting/transfer intervention versus normal practice

Outcome: 4 DASH (no strenuous lifting)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Experimental</th>
<th>Control</th>
<th>Mean Difference</th>
<th>Weight</th>
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</thead>
<tbody>
<tr>
<td>N</td>
<td>Mean(SD)</td>
<td>N</td>
<td>Mean(SD)</td>
<td>IV,Fixed,95% CI</td>
<td>IV,Fixed,95% CI</td>
</tr>
<tr>
<td>Yassi 2001</td>
<td>94</td>
<td>5.5 (8.7)</td>
<td>81</td>
<td>6.3 (10.9)</td>
<td>-0.80 [-3.75, 2.15]</td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>94</td>
<td>81</td>
<td>100.0 %</td>
<td>-0.80 [-3.75, 2.15]</td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: not applicable

Test for overall effect: Z = 0.53 (P = 0.60)

Test for subgroup differences: Not applicable
A P P E N D I C E S

Appendix 1. Cochrane Central Register of Controlled Trials (Clinical Trials) search strategies

2010 Issue 3
ID Search (Hits)
#1 MeSH descriptor Cumulative Trauma Disorders explode all trees (433)
#2 MeSH descriptor Occupational Diseases, this term only (695)
#3 MeSH descriptor Hand-Arm Vibration Syndrome, this term only (0)
#4 MeSH descriptor Occupational Health, this term only (348)
#5 ((occupational overuse or tension neck) NEXT syndrome):ti,ab (2)
#6 (cumulative trauma*):ti,ab (68)
#7 (work related):ti,ab (2295)
#8 (repetit* NEXT (strain or stress or industr* or motion or movement or trauma)):ti,ab (68)
#9 (vibration NEXT (induced or related or syndrome*)):ti,ab (44)
#10 (#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9) (3651)
#11 MeSH descriptor Neck Pain, this term only (372)
#12 MeSH descriptor Shoulder Pain, this term only (255)
#13 MeSH descriptor Hand Injuries explode all trees (175)
#14 MeSH descriptor Wrist Injuries, this term only (92)
#15 MeSH descriptor Musculoskeletal Diseases, this term only (326)
#16 (neck* or shoulder* or arm* or upper limb* or upper extremit* or elbow* or forearm* or wrist* or hand* or finger*):ti,ab (41,531)
#17 (carpal tunnel syndrome*):ti,ab (341)
#18 (#11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17) (42,058)
#19 (#10 AND #18) (880)
#20 MeSH descriptor Human Engineering explode all trees (1849)
#21 MeSH descriptor Biomechanics, this term only (1202)
#22 MeSH descriptor Movement, this term only (1504)
#23 MeSH descriptor Posture, this term only (2419)
#24 MeSH descriptor Lifting, this term only (109)
#25 MeSH descriptor Workload, this term only (319)
#26 MeSH descriptor Workplace, this term only (371)
#27 MeSH descriptor Equipment Design, this term only (3365)
#28 MeSH descriptor User-Computer Interface, this term only (584)
#29 (ergonom* or biomechanic*):ti,ab (837)
#30 (#20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29) (10,927)
#31 (#19 AND #30) (175)

Appendix 2. MEDLINE (Ovid) search strategy

1950 to July Week 1 2010
ID Search (Hits)
1 exp Cumulative Trauma Disorders/ (9191)
2 Occupational Diseases/ or Hand-Arm Vibration Syndrome/ (67,092)
3 Occupational Health/ (20,145)
4 ((occupational overuse or tension neck) adj syndrome).tw. (31)
5 cumulative trauma$.tw. (371)
6 work related.tw. (6671)
7 (repetit$ adj (strain or stress or industr$ or motion or movement or trauma)).tw. (878)
8 (vibration adj (induced or related or syndrome$)).tw. (1011)
9 or/1-8 (96,757)
10 Neck Pain/ or Shoulder Pain/ or exp Hand Injuries/ or Wrist Injuries/ (22,376)
11 Musculoskeletal Diseases/ (6185)
12 (neck$1 or shoulder$1 or arm$1 or upper limb$1 or upper extremi$1 or elbow$1 or forearm$1 or wrist$1 or hand$1 or finger$1).tw.
(525,109)
13 carpal tunnel syndrome$.tw. (4971)
14 or/10-13 (538,959)
15 and/9,14 (12,731)
16 exp Human Engineering/ (36,632)
17 Biomechanics/ (61,952)
18 Movement/ or Posture/ or Lifting/ (94,499)
19 Workload/ or Workplace/ or Equipment Design/ or User-Computer Interface/ (122,209)
20 (ergonom$ or biomechanic$).tw. (30,893)
21 or/16-20 (303,790)
22 and/15,21 (2631)
23 randomized controlled trial.pt. (294,617)
24 controlled clinical trial.pt. (81,941)
25 randomized.ab. (201,684)
26 placebo.ab. (120,362)
27 clinical trials as topic.sh. (149,561)
28 randomly.ab. (146,736)
29 trial.ti. (87,116)
30 23 or 24 or 25 or 26 or 27 or 28 or 29 (683,289)
31 exp animals/ not humans.sh. (3,505,828)
32 30 not 31 (632,169)
33 and/22,32 (236)

Appendix 3. EMBASE search strategy
1980 to 2010 week 28
ID Search (Hits)
1 exp cumulative trauma disorder/ (9573)
2 occupational disease/ or hand arm vibration syndrome/ or occupational accident/ (16,596)
3 occupational health/ or occupational hazard/ or occupational safety/ (29,439)
4 (occupational overuse or tension neck) adj syndrome).tw. (28)
5 cumulative trauma$.tw. (387)
6 work related.tw. (5882)
7 (repetit$ adj (strain or stress or industr$ or motion or movement or trauma)).tw. (860)
8 (vibration adj (induced or related or syndrome$)).tw. (850)
9 or/1-8 (54,880)
10 shoulder pain/ or neck pain/ or arm injury/ or exp hand injury/ or shoulder injury/ or wrist injury/ or elbow injury/ (23,557)
11 musculoskeletal disease/ (10,110)
12 (neck$1 or shoulder$1 or arm$1 or upper limb$1 or upper extremi$1 or elbow$1 or forearm$1 or wrist$1 or hand$1 or finger$1).tw. (451,430)
13 carpal tunnel syndrome$.tw. (4361)
14 or/10-13 (468,629)
15 and/9,14 (11,946)
16 exp bioengineering/ (39,182)
17 biomechanics/ (36,340)
18 "movement (physiology)"/ or body posture/ (24,187)
19 workload/ or workplace/ or equipment design/ or human computer interaction/ or visual display unit/ or ergonomics/ (40,803)
20 (ergonom$ or biomechanic$).tw. (27,299)
21 or/16-20 (142,203)
22 and/15,21 (2343)
23 stress fracture/ (2954)
Appendix 4. Web of Science search strategy

19 Jul 2010

<table>
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<th>Search</th>
<th>Hits</th>
</tr>
</thead>
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<td>#12 AND #11</td>
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</tr>
<tr>
<td>#12</td>
<td>Topic=((random* or placebo*)) OR Topic=((singl* or doubl* or treb* or tripl*) SAME (blind* or mask*)) OR Topic=(clinical SAME trial*) OR Title=(trial)</td>
<td>&gt;100,000</td>
</tr>
<tr>
<td>#11</td>
<td>#10 AND #9</td>
<td>1855</td>
</tr>
<tr>
<td>#10</td>
<td>Topic=((biomechanic* or engineer* or ergonomic* or support* or equipment))</td>
<td>&gt;100,000</td>
</tr>
</tbody>
</table>
Appendix 5. CINAHL search strategy

<table>
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<tr>
<th>ID</th>
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<td>S36</td>
<td>S22 and S35</td>
<td>239</td>
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<tr>
<td>S35</td>
<td>S23 or S24 or S25 or S26 or S27 or S28 or S29 or S30 or S31 or S32 or S33 or S34</td>
<td>340,649</td>
</tr>
<tr>
<td>S34</td>
<td>TI (crossover or cross-over or &quot;cross over&quot;) or AB (crossover or cross-over or &quot;cross over&quot;)</td>
<td>5270</td>
</tr>
<tr>
<td>S33</td>
<td>TI (singl* N1 blind*) or TI (doubl* N1 blind*) or TI (trebl* N1 blind*) or TI (tripl* N1 blind*) or TI (singl* N1 mask*) or TI (doubl* N1 mask*) or TI (trebl* N1 mask*) or TI (tripl* N1 mask*) or AB (singl* N1 blind*) or AB (doubl* N1 blind*) or AB</td>
<td>13,436</td>
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(Continued)

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<tbody>
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<td>S32</td>
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<td>23,944</td>
</tr>
<tr>
<td>S31</td>
<td>TI (clinical or controlled or comparative or placebo or prospective or randomised or randomized) and (trial or study) or AB (clinical or controlled or comparative or placebo or prospective or randomised or randomized) and (trial or study)</td>
<td>151,868</td>
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<tr>
<td>S30</td>
<td>PT Clinical Trial</td>
<td>57,542</td>
</tr>
<tr>
<td>S29</td>
<td>(MH &quot;Random Assignment&quot;)</td>
<td>26,564</td>
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<tr>
<td>S28</td>
<td>(MH &quot;Placebos&quot;)</td>
<td>6126</td>
</tr>
<tr>
<td>S27</td>
<td>(MH &quot;Double-Blind Studies&quot;) or (MH &quot;Single-Blind Studies&quot;) or (MH &quot;Triple-Blind Studies&quot;)</td>
<td>21,909</td>
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<tr>
<td>S26</td>
<td>(MH &quot;Crossover Design&quot;)</td>
<td>6788</td>
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<td>S25</td>
<td>(MH &quot;Prospective Studies+&quot;)</td>
<td>128,264</td>
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<td>S24</td>
<td>(MH &quot;Comparative Studies&quot;)</td>
<td>57,426</td>
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<td>S23</td>
<td>(MH &quot;Clinical Trials+&quot;)</td>
<td>101,195</td>
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<td>S15 and S21</td>
<td>921</td>
</tr>
<tr>
<td>S21</td>
<td>S16 or S17 or S18 or S19 or S20</td>
<td>59,759</td>
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<tr>
<td>S20</td>
<td>TI ((ergonom* or biomechanic*)) or AB ((ergonom* or biomechanic*))</td>
<td>7238</td>
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<tr>
<td>S19</td>
<td>(MH &quot;Workload&quot;) or (MH &quot;Work Environment&quot;) or (MH &quot;Equipment Design&quot;) or (MH &quot;User-Computer Interface&quot;)</td>
<td>31,737</td>
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<tr>
<td>S18</td>
<td>(MH &quot;Movement&quot;) or (MH &quot;Posture&quot;) or (MH &quot;Lifting&quot;)</td>
<td>10,766</td>
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<tr>
<td>S17</td>
<td>(MH &quot;Biomechanics&quot;)</td>
<td>9231</td>
</tr>
<tr>
<td>S16</td>
<td>(MH &quot;Ergonomics+&quot;)</td>
<td>10,359</td>
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</table>

Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults (Review)

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### Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults (Review)

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<table>
<thead>
<tr>
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<th>S9 and S14</th>
<th>3170</th>
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</thead>
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</tr>
<tr>
<td>S13</td>
<td>TI carpal tunnel syndrome* or AB carpal tunnel syndrome*</td>
<td>1028</td>
</tr>
<tr>
<td>S12</td>
<td>TI (neck* or shoulder* or arm* or upper limb* or upper extremi* or elbow* or forearm* or wrist* or hand* or finger*) or AB (neck* or shoulder* or arm* or upper limb* or upper extremi* or elbow* or forearm* or wrist* or hand* or finger*)</td>
<td>79,650</td>
</tr>
<tr>
<td>S11</td>
<td>(MH &quot;Musculoskeletal Diseases&quot;)</td>
<td>2933</td>
</tr>
<tr>
<td>S10</td>
<td>(MH &quot;Neck Pain&quot;) or (MH &quot;Shoulder Pain&quot;) or (MH &quot;Arm Injuries&quot;) or (MH &quot;Hand Injuries&quot;) or (MH &quot;Hand Injuries&quot;) or (MH &quot;Finger Injuries&quot;) or (MH &quot;Wrist Injuries&quot;) or (MH &quot;Shoulder Injuries&quot;)</td>
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<td>S1 or S2 or S3 or S4 or S5 or S6 or S7 or S8</td>
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<td>S8</td>
<td>TI (vibration N1 induced) or (vibration N1 related) or (vibration N1 syndrome*) or AB (vibration N1 induced) or (vibration N1 related) or (vibration N1 syndrome*)</td>
<td>80</td>
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<tr>
<td>S7</td>
<td>TI (repetit* N1 strain) or (repetit* N1 stress) or (repetit* N1 industr*) or (repetit* N1 motion) or (repetit* N1 movement) or (repetit* N1 trauma) or AB (repetit* N1 strain) or (repetit* N1 stress) or (repetit* N1 industr*) or (repetit* N1 motion) or (repetit* N1 movement) or (repetit* N1 trauma)</td>
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</tr>
<tr>
<td>S6</td>
<td>TI work related or AB work related</td>
<td>2758</td>
</tr>
<tr>
<td>S5</td>
<td>TI cumulative trauma* or AB cumulative trauma*</td>
<td>173</td>
</tr>
<tr>
<td>S4</td>
<td>TI (occupational overuse N1 syndrome) or (tension neck N1 syndrome) or AB (occupational overuse N1 syndrome) or (tension neck N1 syndrome)</td>
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<td>(MH &quot;Occupational Diseases&quot;)</td>
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<td>(MH &quot;Cumulative Trauma Disorders+&quot;)</td>
<td>3235</td>
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</table>
Appendix 6. AMED (Allied and Complementary Medicine) search strategy

1985 to Jul 2010

ID Search (Hits)
1 repetition strain injury/ (268)
2 occupational disease/ (1491)
3 occupational health/ (127)
4 ((occupational overuse or tension neck) adj syndrome).tw. (6)
5 cumulative trauma$.tw. (91)
6 work related.tw. (686)
7 (repetit$ adj (strain or stress or industr$ or motion or movement or trauma)).tw. (393)
8 (vibration adj (induced or related or syndrome$)).tw. (26)
9 or/1-8 (2382)
10 Neck Pain/ or Shoulder Pain/ or "Wounds and Injuries"/ or Arm Injuries/ or exp Hand Injuries/ or Arm Injuries/ or Forearm Injuries/ or Shoulder Injuries/ or Wrist Injuries/ (1755)
11 Musculoskeletal disease/ (1549)
12 (neck$1 or shoulder$1 or arm$1 or upper limb$1 or upper extrem$1 or elbow$1 or forearm$1 or wrist$1 or hand$1 or finger$1).tw. (15,860)
13 carpal tunnel syndrome$.tw. (411)
14 or/10-13 (17,399)
15 and/9,14 (734)
16 human engineering/ (733)
17 Biomechanics/ (11,747)
18 Movement/ or Posture/ or Lifting/ (7559)
19 Workload/ or Workplace/ or Equipment Design/ or "Computers and Computing"/ (3885)
20 (ergonom$ or biomechanic$).tw. (13,922)
21 or/16-20 (21,665)
22 and/15,21 (300)
23 randomized controlled trial.pt. (1569)
24 controlled clinical trial.pt. (70)
25 Randomized Controlled Trials/ (1381)
26 Random Allocation/ (288)
27 Double-Blind Method/ (391)
28 or/23-27 (3541)
29 exp Animals/ not Humans/ (5451)
30 28 not 29 (3521)
31 clinical trial.pt. (1107)
32 exp Clinical trials/ (3003)
33 (clinic$ adj25 trial$).tw. (4941)
34 ((singl$ or doubl$ or trebl$ or tripl$) adj (mask$ or blind$)).tw. (1972)
35 Placebos/ (506)
36 placebo$.tw. (2345)
37 random$.tw. (11,231)
38 exp Research design/ (16,830)
39 (latin adj square).tw. (24)
40 or/31-39 (27,693)
41 40 not 29 (27,286)
42 41 not 30 (23,819)
43 and/22,42 (32)
### Appendix 7. SPORTDiscus search strategy
16 Jul 2010

<table>
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<tr>
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<td>TX placebo*</td>
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<tr>
<td>S26</td>
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<td>TX randomized control* trial*</td>
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Appendix 8. 'Risk of bias' tool

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<tr>
<td>Sequence generation</td>
<td>Describe the method used to generate the allocation sequence in sufficient detail to allow an assessment of whether it should produce comparable groups</td>
<td>Was the allocation sequence adequately generated? Yes/ No/ Unclear</td>
</tr>
<tr>
<td>Allocation concealment</td>
<td>Describe the method used to conceal the allocation sequence in sufficient detail to determine whether intervention allocations could have been foreseen in advance of, or</td>
<td>Was allocation adequately concealed? Yes/ No/ Unclear</td>
</tr>
<tr>
<td>Topic</td>
<td>Description</td>
<td>Was knowledge of the allocated intervention adequately prevented during the study?</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Blinding of participants, personnel and outcome assessors</td>
<td>Describe all measures used, if any, to blind study participants and personnel from knowledge of which intervention a participant received. Provide any information relating to whether the intended blinding was effective</td>
<td>Yes/No/Unclear</td>
</tr>
<tr>
<td>Incomplete outcome data</td>
<td>Describe the completeness of outcome data for each main outcome, including attrition and exclusions from the analysis. State whether attrition and exclusions were reported, the numbers in each intervention group (compared with total randomised participants), reasons for attrition/exclusions where reported, and any re-inclusions in analyses performed by the review authors</td>
<td>Yes/No/Unclear</td>
</tr>
<tr>
<td>Selective outcome reporting</td>
<td>State how the possibility of selective outcome reporting was examined by the review authors, and what was found</td>
<td>Are reports of the study free of suggestion of selective outcome reporting? Yes/No/Unclear</td>
</tr>
<tr>
<td>Other sources of bias</td>
<td>State any important concerns about bias not addressed in the other domains in the tool If particular questions/entries were prespecified in the review's protocol, responses should be provided for each question/entry</td>
<td>Was the study apparently free of other problems that could put it at a high risk of bias? Yes/No/Unclear</td>
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**WHAT'S NEW**

Last assessed as up-to-date: 31 October 2010.

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
<th>Description</th>
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<td>28 July 2010</td>
<td>Amended</td>
<td>The order of the authors has been amended.</td>
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HISTORY
Protocol first published: Issue 7, 2010
Review first published: Issue 8, 2012

CONTRIBUTIONS OF AUTHORS
The principal author (VCWH) initiated and planned the review and administrated the review process.

All authors (VCWH, HLK, DMU, and MRS) were involved in writing the protocol. The principal author (VCWH) developed the search strategy in association with Lesley Gillespie of the Cochrane Bone, Joint and Muscle Trauma Group.

Two review authors (VCWH and MRS) participated in the decision-making process regarding the inclusion and exclusion of the studies. Two review authors (VCWH and DMU) conducted the data extraction, 'Risk of bias' assessment and quality assessment. One review author conducted the data synthesis (VCWH). All authors (VCWH, HLK, DMU, and MRS) were involved in writing the review.

DECLARATIONS OF INTEREST
None known.

SOURCES OF SUPPORT

Internal sources
• University of Malaya, Kuala Lumpur, Malaysia.
• Department of Epidemiology & Preventive Medicine, Monash University, Melbourne, Australia.

External sources
• Ministry of Higher Education's Academic Training Scheme, Malaysia.
• National Health and Medical Research Council's Public Health Postdoctoral Fellowship, Australia.
• National Health and Medical Research Council's Public Health Capacity Building Grant, Australia.

DIFFERENCES BETWEEN PROTOCOL AND REVIEW
The Cochrane Occupational Health Field's register has been changed to Cochrane Occupational Safety and Health review group database. We excluded the Current Controlled Trials database as the ICTRN databases included all the databases in the Current Controlled Trial database. The grading of the quality of evidence by the Grade approach was included.
7. Discussion

As identified in Chapter One, the main interlinking theme of this thesis is work-related MSDs of the neck and upper limb and investigating current gaps in two main areas related to this theme. The first part of the thesis addressed some important gaps in the current literature relating to hospital-based nurses, a work group at high risk of developing WRULDs. This study resulted in three series of analyses presented in this thesis. The first of these is a published paper in Occupational & Environmental Medicine (chapter 2) which involved a cross-sectional analysis which identified the differences in risk factors associated with pain in one site or in combination in relation to the neck and shoulder, which had not been well covered in the literature. These differences have important implications, as expanded upon later in this chapter, in terms of the prevention of multisite pain, as well as potentially in the management of nurses who report pain in more than one site.

The second set of analyses related to risk factors for hand or wrist pain in nurses, an area of the body which has received scant attention in the literature despite nurses often needing to undertake repetitive and forceful wrist and hand movements. This analysis has resulted in a paper which has been published in Injury Prevention (Chapter 3) and this should help to promote the importance of this problem in nurses and assist in the development of prevention programmes. The third set of analyses took a longitudinal approach to investigate the relationship between multisite musculoskeletal pain and the nurses’ perceived work ability, an important measure in relation to longer term impact of WRULDs in nurses. Little has been previously published in relation to work ability in nurses, although this is becoming a common measure used in studies of other occupational groups.
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The second part of the thesis linked into the overall theme of WRULDs by undertaking a Cochrane Systematic Review on ergonomic interventions for the prevention of WRULDs, which has been published in the Cochrane Library (Chapter 6). The review was preceded by the development of a peer-reviewed study protocol, which has also been published in the Cochrane Library (Chapter 5).

7.1 Risk factors associated with WRULDs in hospital-based nurses

The first paper (Chapter 2) presented a novel approach in addressing the risk factors for neck and shoulder pain. Although the neck and shoulders are sometime considered a single unit in clinical practice, it may be difficult to disentangle the effect of risk factors on the individual sites. Therefore an important question relates to the factors which lead to some people reporting pain in either the neck or shoulder alone and why others report pain in both sites. Therefore, it is important to identify those risk factors specific to neck or shoulder alone, and those related to neck and shoulder pain together, which was the main focus of the published paper in chapter 2. The findings from this analysis should be useful in the design of preventive measures, such as work stations with adjustable height to cater workers of different height to reduce neck discomfort and biopsychology programmes for multisite musculoskeletal pain.

In this thesis, the pain at individual sites; i.e., neck pain alone, shoulder pain alone, and neck and shoulder pain, were individually compared with those reporting no neck or shoulder pain, and were also adjusted for pain in other anatomical sites (i.e., low back, elbow, wrist or hand, and knee). This approach has produced some interesting results, as the risk factors associated with neck pain alone, shoulder pain alone and neck and shoulder pain in nurses were different. While somatisation tendency and work-causation beliefs had the strongest association with neck and shoulder pain; mental and physical health and well-being,
workplace physical load factors and other demographic factors were also associated with neck and shoulder pain. These factors were less consistently associated with neck pain alone or shoulder pain alone. Factors associated with neck pain alone and shoulder pain alone differed: neck pain alone was associated with demographic and anthropometric factors including height and BMI, whereas shoulder pain alone was associated with health beliefs. The only factor that was associated with pain in all three outcome categories was physical health and wellbeing.

This thesis has found that having originated from a country in the Asian continent and increasing BMI showed decreased odds of reporting neck pain. A possible explanation for the findings that reporting of neck pain alone was associated with the country of origin may be the influence of cultural factors. However, this is difficult to explain, as it only relates to neck pain alone and not to shoulder pain alone or neck and shoulder pain. Further, research investigating cultural differences in reporting of musculoskeletal symptoms and disability between manual and office workers from India and the United Kingdom found lower prevalence for all sites of musculoskeletal pain among Indians compared to those in the United Kingdom (Madan et al., 2008). The findings in my study could be due to the misinterpretation of the questions on neck pain or the perception that neck and shoulder are considered as a single unit among this group of workers.

Obesity has been found to be associated with an increased risk of neck pain among workers of nursing homes in the Netherlands (Luime et al., 2004), and among municipal workers in Finland (Kaaria et al., 2012). Most of the studies on neck pain include those with shoulder pain, the effect of neck pain alone could not be ascertained in those studies. In my study, overweight and obese nurses had decreased odds of reporting neck pain alone. This finding of a protective effect may indicate that neck pain alone could be due to mechanical causes as the
fat around the neck may be protective. However this could not be substantiated in the current study as the composition of fat around the neck was not studied. It also could be influenced by the cross-sectional design of the study.

The second paper (Chapter 3) addressed another important occupational health condition among nurses. Wrist and hand function plays an essential role in both activities of daily living and work function. Wrist and hand function is important among nurses who are involved with regular manual handling activities, as well as fine movements of the hands and fingers. The study identified that both physical and psychological factors, particularly repeated movement of the wrist or fingers for greater than four hours, somatising tendency and physical health and wellbeing were associated with wrist or hand pain. This has important implications for prevention for those nursing tasks requiring rapid or forceful movements, such as during perioperative and critical care.

**Somatisation tendency and health beliefs**

Somatisation tendency is a generally increased awareness of, and tendency to report, somatic symptoms (Barsky et al., 1988). The somatic symptoms used in this thesis included nausea, faintness, dizziness, weakness, numbness in the body, chest pain and breathing difficulties reported over the past seven days. Somatisation tendency was found to be associated with both neck and shoulder pain and wrist or hand pain. The results are consistent with those in a cohort of workers in the United Kingdom (Macfarlane et al., 2000), where somatic distress predicted incident of forearm pain. In a cross-sectional study on nurses, office workers and postal workers, somatisation was associated with multiple sites musculoskeletal pain (Solidaki et al., 2010).
Addressing somatisation tendency and other health beliefs could be a strategy for preventing WRULDs and other widespread pain, limiting disability and preventing persistence of pain, as somatisation has also been implicated for the transition to chronic low back pain (Pincus et al., 2002). Somatisation tendency which is a process by which psychological distress is expressed as physical symptoms; it could be reduced by modifying the beliefs and expectation of the individual. However there is still limited evidence on an effective intervention. In Victoria, Australia, a community-based intervention aimed at modifying people’s beliefs and expectations about back pain was followed by positive beliefs among the general population and doctors, and a reduction in morbidity among those exposed to the campaign (Buchbinder et al., 2001). However a similar intervention in Norway aimed at healthcare providers did not result in important improvements in low back pain beliefs of providers exposed to the campaign (Werner et al., 2008).

Physical health and wellbeing

A consistent finding in this thesis was that poorer physical health and wellbeing was associated with neck and upper limb pain. There is currently limited research looking at physical health and wellbeing in relation to MSDs of the neck and upper limb. Only two studies were identified; in a cross-sectional study, Langerström et al (Lagerström et al., 1995) found that low physical fitness was associated with shoulder and neck pain among Swedish nurses, and in a longitudinal study, Hamberg-van Reenen et al (Hamberg-van Reenen et al., 2006) found low physical capacity predicts neck pain among Dutch workers. The association may arise because one of the dimensions in the 12 item Short Form Health Survey (SF-12 v2) instrument used to measure physical health and wellbeing is pain (Ware et al., 2002), however the dimension on pain, only contributes a small component to the overall score. The findings that poorer physical health and wellbeing are associated with MSDs of the neck and
upper limb would be useful in the prevention of WRULDs. Improving the physical health and wellbeing may be beneficial and could prevent WRULDs. A Cochrane Systematic Review on the use of exercise for treatment of mechanical disorders has found that there is a role in the treatment of both acute and chronic mechanical neck disorders (Kay Theresa et al., 2005).

**Workplace psychosocial factors**

This thesis has found that workplace psychosocial factors were not associated with self-reported neck, and upper limb pain among nurses. This finding is in contrast to those of previous studies, in which workplace psychosocial factors have been consistently found to be associated with MSDs in general working populations, with attributable fractions as high as 84% (Palmer et al., 2008, Marras et al., 2009, Cote et al., 2008). The reason for the lack of association between workplace psychosocial factors and WRLUDs in the current nurses’ study may be that personal and psychosocial factors such as somatisation tendency, health beliefs, and physical health and wellbeing have a more important role than workplace psychosocial factors alone. Our findings in relation to this hypothesis had some similarities with previous studies on nurses and healthcare personnel, whereby two prospective studies on healthcare workers did not find any association between workplace psychosocial factors and neck or shoulder pain after adjusting for socio-demographic, workplace physical, and personal psychosocial factors (Smedley et al., 2003, Luime et al., 2004). Similarly, previous cross-sectional studies of workplace psychosocial factors found no association with neck and shoulder pain after adjusting for workplace physical and personal psychosocial factors (Alexopoulos et al., 2003, Bos et al., 2007, Choobineh et al., 2006).

The healthcare profession, including the nursing profession may have a unique advantage. They are exposed to various physical, psychosocial and organisational factors that are also present in other professions, but due to their professional training and experience the nurses
may express symptoms of MSDs differently. It has been observed that, there were considerable differences between the disease concepts held by the general public and healthcare professionals (WHO, 2003).

**Work ability**

Chapter 4 assessed the relationship between multisite musculoskeletal pain at baseline and reduced work ability one year later. The risk of reduced work ability increased with an increase in the number of painful sites, with those who had musculoskeletal pain in more than two sites reporting the highest risk. These findings further expand upon the results from an earlier cross-sectional study on a general working population in Finland (Miranda et al., 2010) by showing in a longitudinal analysis that previously reported multiple sites of musculoskeletal pain were strongly associated with reduced self-perceived work ability one year later.

Although somatisation tendency was found in this thesis to be associated with musculoskeletal pain, it did not predict reduced work ability. Other personal psychosocial factors, such as low resilience and pain catastrophising, were found to predict reduced work ability. The findings in this thesis indicated that individuals’ resilience, which is the dynamic process of positive adaptation in the face of stress or trauma (Luthar et al., 2000), and pain catastrophising, their expression of worry and excessive focus on negative aspects of their painful situation (Spanos et al., 1979), were more important than somatisation tendency, a process by which psychological distress is expressed as physical symptoms. This may suggest that musculoskeletal pain and the individuals’ response to the pain itself are important in determining the level of work ability. The findings that being overweight or obese, low job satisfaction and poor mental health are independent risk factors for reduced work ability.
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provides further evidence to support the findings in a published systematic review (van den Berg et al., 2009).

7.2 Ergonomic interventions for preventing WRULD

The Cochrane review in this thesis found moderate quality evidence to suggest that the use of an arm support with alternative mouse may reduce the incidence of neck/shoulder MSDs, but not right upper limb MSDs. Moreover, there was moderate quality evidence to suggest that the incidence of neck/shoulder and right upper limb MSDs was not reduced when comparing alternative mouse and conventional mouse with and without arm support. However, given there were multiple comparisons made, involving a number of interventions and outcomes, high quality evidence is needed to clearly determine the effectiveness of these interventions.

There was also very low to low quality evidence to suggest that other ergonomic interventions do not prevent work-related MSDs of the upper limb and neck, however this was limited by the paucity and heterogeneity of available studies. The reason for the lack of studies may be due to the complexity and difficulty of conducting RCTs in an occupational setting. The issues include the difficulty for randomisation of workplace or workers, in minimising the effect from contamination of intervention process, in sustainability of the intervention, in maintaining the study population and in blinding of the intervention subjects. At least some of these issues could be overcome with more carefully designed studies having adequate numbers of participants, standardised methods to assess outcomes, and independent outcome assessment.

The Cochrane review in this thesis found that a simple intervention that required minimal input from the workers and those who implemented the intervention seems to have a better outcome. The simple intervention of giving the participants an arm support board and
alternative mouse based on ergonomic principles (Conlon et al., 2008, Rempel et al., 2006) was found to have a better outcome than a complex intervention with specific instructions for placement of the monitor, keyboard, mouse, arm rest and chair which are also based on the same ergonomic principles (Gerr et al., 2005).

The method of applying a simple approach to reduce workplace injuries has been successful in reducing back injuries among nurses in Victoria, Australia. The main focus of the intervention was ‘No Lifting’ policy, a radical departure from previous approaches which focused on training of nurses in manual lifting techniques, exercise and fitness (DHSV, 2004). Over the period of the program there was an estimated 24% reduction in the rate of standard back injury claims and a 41% reduction in the rate of working days lost associated with standard back injuries among nurses.

There are two possible explanations for the success of simple interventions for the prevention of work-related MSDs, whether related to the neck/shoulder or the lower back. The first is that simple interventions are easier to follow and comply with compared to a more complex one. The second explanation is that the multiple risk factors associated with work-related MSDs included psychological and workplace psychosocial factors and the complexity of the intervention could have increased these risk factors which may be counterproductive.

7.3 Strengths and limitations

Chapters 2 and 3 had some potential limitations. The assessment of risk factors for neck, shoulders and wrist or hand pain was based on cross-sectional data, as no longitudinal data were available at that time. Therefore it was not possible to assess the direction of association of those risk factors. Whilst the response of rate of 39% was lower than the reported response rate of 58% (nurses, postal and office workers combined) for the New Zealand (Harcombe et
Chapter 7
al., 2009) and 56% (nurses only) for the Japanese (Matsudaira et al., 2011) arm of the CUPID study, it is comparable to recent studies conducted among nurses from several European countries (Latour et al., 2009, Camerino et al., 2006). The decreasing response to requests to take part in research is a current trend especially among western industrialised countries (Morton et al., 2006, Galea and Tracy, 2007). The reason could be a general decrease in volunteerism, higher demands for participation, and over surveying (Galea and Tracy, 2007). Although it has been suggested that web-based questionnaires may increase the response rate (van Gelder et al., 2010), it was found that in our survey less than 5% completed the online questionnaires. The low response rate may contribute to potential bias, as a small different between those who have responded and those who did not response in terms of reporting pain or the other variables studied in this thesis may have materially affected the findings. Therefore, the possibility of low response highlights the importance of having some demographic and other data relating to the whole population, to make comparisons and assess representativeness of the study participants. Due to privacy restrictions, it was not possible to have full access to the characteristics of the study population and it was difficult to fully determine the study sampling frame, which was based on AlfredHealth payroll database at the time of the baseline study. Access to check contact details was not possible due to these privacy restrictions, so questionnaires that were returned to sender were considered non-contactable and were excluded from the sampling frame. However de-identified summary demographic data obtained on the whole study population at the time of establishing the sampling frame showed that the differences between the participants and the total hospital nursing population were small.

Chapters 2 and 3 also had some strengths. The participants were comparable to the total population and the number of eligible participants (N=1,111) was adequate to address the research questions for both chapters. In Chapter 4, the response rate for the follow-up survey
was acceptable (75%). Possible explanations for this higher follow-up rate could be that those who had agreed to participate at baseline were more likely to participate again, direct contact details for the participants were available and they were able to be contacted through email and telephone as part of the recruitment strategy, and participants were again eligible to go into a draw to win one of 10 modest value vouchers from a well-known department store.

A further strength is that the core CUPID questionnaire on musculoskeletal disease, physical and psychosocial factors had been used in an earlier study (Madan et al., 2008) and was based on validated questionnaires; i.e., questions on musculoskeletal symptoms were adapted from the Nordic Questionnaire on musculoskeletal complaints (Kuorinka et al., 1987), workplace psychosocial factors were assessed based on the job control and demand model (Karasek et al., 1981), somatising tendency was assessed using the somatisation scale of the Brief Symptom Inventory (Derogatis and Melisaratos, 1983), fear-avoidance beliefs were assessed using questions from the Fear-Avoidance Beliefs Questionnaire (Waddell et al., 1993) and mental health was assessed using the Mental Health Inventory-5 (MHI-5) (Berwick et al., 1991). The additional instruments used in the Australian Nurses’ Work and Health Study included questions from validated instruments; i.e., the Pain Catastrophizing Scale (PCS) (Sullivan et al., 1995), Connor-Davidson Resilience Scale (CD-RISC) (Connor and Davidson, 2003, Campbell-Sills and Stein, 2007), and the 12 item Short Form Health Survey (SF-12v2) (Ware et al., 2002).

The paper (Chapter 4) on work ability reported prospectively the determinants and covariates assessed during a baseline survey and the outcome variable for work ability assessed during follow-up at 12 months. The work ability was assessed using a modified Work Ability Index (WAI) questionnaire (Tuomi et al., 1998). The modified WAI questionnaire was derived from the six sections of the original WAI questionnaire, with the section on diseases diagnosed by
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a physician removed. We did not include this section on the number of current diseases diagnosed by a physician, as it was of considerable length and validated questions on musculoskeletal pain at several body sites and the number of musculoskeletal pain sites that would have correlated with such an outcome variable were already included in the existing questionnaire.

The validity of the modified WAI was not ascertained in the current study. There are several studies that have used different version of the WAI instrument. Miranda et al (Miranda et al., 2010) also excluded the section on the number of current diseases diagnosed by a physician in their study on multiple site musculoskeletal pain and work ability, and noted that the section would have correlated with their assessment of musculoskeletal pain. Similarly to the current study Laitinen et al (Laitinen et al., 2005) removed the item on the number of current diseases diagnosed by a physician, and used the 15th percentile as the cut-off for those with low WAI. The value of the low WAI corresponds to the medium/poor category used in our study (6-29) (Laitinen et al., 2005). Some researchers have used a single-item to assess work ability (Sluiter and Frings-Dresen, 2008, Ahlstrom et al., 2010, de Croon et al., 2005). The original WAI has been found to be a highly predictive instrument of work ability in a nursing population and has a high level of cross-national stability (Radkiewicz and Widerszal-Bazyl, 2005).

Chapters 2, 3 and 4 have some further limitation; the assessment of the work place physical risk factors was based on questionnaire for general physical risk factors which were not specific to nurses. This limitation was the result of the original intention was to include two other occupational groups (office and postal workers) in the study. However this could not be done due to the inability to obtain additional funding to study those occupational groups.
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7.4 Emerging Themes and Implications

This thesis aimed to identify the risk factors associated with WRULDs, in particular neck, shoulder and wrist or hand pain, identify the relationship between work ability and musculoskeletal pain, and to conduct a systematic review on interventions for preventing WRULDs.

One of the significant themes which has emerged is that the thesis has provided further evidence to support one of the conceptual models for the development of work-related MSDs, that individual factors, such as ability to cope and personality may interact with workplace organisational factors and serve as co-determinants of stress responses and their effects on WRULDs (Huang et al., 2002). These findings also fit with the proposed model in Chapter 1, where both individual and workplace factors influences the progression of WRULDs, as it was found that somatisation tendency, health beliefs and physical health and wellbeing were associated with WRULDs.

Whilst the finding indicates that somatisation tendency was associated with WRULDs among nurses in a cross-sectional study, it was not possible to determine the direction of association. Further analysis of the dataset including both the baseline and the follow-up data is needed. The analysis should assess whether the baseline factors predict persistence, resolution and development of pain during follow-up, whether the change in the risk factors from baseline are associated with persistence, resolution or development of musculoskeletal pain, and also assessment of the stability of the measures of somatising tendency and other personal psychosocial factors over time among nurses. Future analysis should also compare data on nursing populations from the international CUPID studies to assess the relationship between cultural values and WRULDs. The Australian arm has contributed baseline and follow up
data to the international collaborative CUPID study that will enable this and this has led to a published paper on which I am a co-author (Coggon et al.).

The second theme that emerges is that multisite musculoskeletal pain, workplace factors and personal psychosocial factors predict reduced work ability. Work ability can be described as a measure of a worker’s capacity to perform his or her work based on work content and job demand (Ilmarinen, 2009). The identification that multisite musculoskeletal pain predicts reduced work ability has important implications for workforce retention, especially at the present time, as developed countries are facing nursing shortages. These further highlight the importance of reducing WRULDs to improve work ability.

In the Cochrane systematic review the focus was only on ergonomic interventions for preventing WRULDs and the simple direct intervention of using an alternative mouse with an arm support board was found to be successful in preventing the incidence and symptoms of WRULDs. The findings have important implications for determining ergonomic interventions and education to be implemented in occupational settings in the prevention of work-related MSDs of the neck and upper limb. Future study on intervention should focus on simple interventions for the prevention of work place injury, more particularly work-related MSDs as this may be more effective than more complex interventions.

However, given the review identified only a small number of studies with low risk of bias and significant heterogeneity between the studies, there is a need for high quality RCTs examining ergonomic interventions for WRULDs. These studies should include participants from both developed and developing countries, include other occupational groups with different risk of injuries (e.g., construction industry), have standardised assessment methods and have robust randomisation processes.
Chapter 7

Preventing musculoskeletal disorder among nurses should be set as a priority, and besides focusing on ergonomic factors, psychosocial factors also need to be considered in interventions.
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Appendix A

Appendix A: Australian Nurses’ Work and Health Study baseline questionnaire
Australian Nurses’ Work and Health Study

Australian arm of the CUPID Study
International Survey of Physical, Cultural and Psychosocial Influences on Musculoskeletal Symptoms and Associated Disability
You can also complete this questionnaire online!

Visit: https://cupid.coeh.monash.org

and log in with your unique ID number and password:

Study ID  A 1 2 3 9

Password  0 8 B 1 C D
INFORMED CONSENT STATEMENT

AUSTRALIAN NURSES' WORK AND HEALTH STUDY

Please read the following statement and place your signature in the space provided if you agree with the provisions of the study.

In signing this consent form I am declaring the following:

I agree to take part in the Australian Nurses’ Work and Health Study.

I have read and understood the Study Information Booklet.

I have had the opportunity to ask questions arising from the Information Booklet via the Monash University freecall number 1800 818 765.

I understand that my participation in the study requires completion of this questionnaire and that the study team will contact me in approximately 12 months time with a follow-up questionnaire for completion. The follow-up questionnaire will cover similar topics to this current one, but will be much shorter.

I understand that I am participating in this study in a voluntary capacity, and that at any time I can withdraw from the study.

I am participating in this study on the provision that the information I provide will be kept confidential and that any published reports of this study will preserve my anonymity.

Participant’s name

Participant’s signature Date .../.../......

To be able to contact you in 12 months time for the follow-up questionnaire we need your contact details. Please complete the contact details on the next page.

Note: to ensure confidentiality of your information, this page including the contact details will be removed by the Monash University study team and stored separately from the rest of the questionnaire.

Thank you for participating in this study. Your contribution is important to us.
CONTACT DETAILS

Surname (in capitals): 

Other name (s): 

Address, street number and street or PO Box: 

Suburb/Town: 

State: [ ] Post code: [ 

Phone: home ( [ ] [ ] [ ] ) [ ] [ ] 

Phone: mobile [ ] [ ] [ ] [ ] [ ] [ ] 

Email address: [ ] [ ] [ ] [ ] [ ] [ ]

ALTERNATIVE CONTACT DETAILS

In case you move and we lose contact with you, please provide the name and contact details of an alternative contact - a relative or friend who may be able to tell us where you are. This should be a person who is at a long-term address but who is not living with you. We would only use this alternative contact in the event that we cannot contact you at the address you provided.

Surname (in capitals): 

Other name (s): 

Address, street number and street or PO Box: 

Suburb/Town: 

State: [ ] Post code: [ ] [ ] [ ]

Phone: home ( [ ] [ ] [ ] ) [ ] [ ]

Phone: mobile [ ] [ ] [ ] [ ] [ ] [ ]

Email address: [ ] [ ] [ ] [ ] [ ] [ ]
Please read the following instructions regarding the completion of this questionnaire

When completing the questionnaire please place a cross [X] or a tick [☑] in the boxes corresponding to your answers. Please DO NOT circle the box [☐] or mark outside the box.

Fill in with text and numbers where appropriate. Use a blue or black pen.

If you make a mistake or want to change your answer please use correction fluid and mark the correct box.

Please ring the Study team if you are unsure about how to complete any section of this questionnaire.

The freecall number is 1800 818 765.

Please fill in the date that you complete this form Date: ☐ ☐ ☐

day month year

SECTION ONE: ABOUT YOURSELF

1a) Please fill in your date of birth ☐ ☐ ☐

day month year

1b) your age ☐ years

2. and your sex Male ☐ Female ☐

3. Are you right or left handed? Right ☐ Left ☐ Both equally ☐

4a) How would you best describe your ethnic origin?

Australian ☐ English ☐ Irish ☐
Scottish ☐ Italian ☐ German ☐
Chinese ☐ Greek ☐ Dutch ☐
Indian ☐ Bangladeshi ☐ Pakistani ☐
Black African / Carribean ☐ Other (please specify) ☐

4b) In which country were you born?

Australia ☐ New Zealand ☐ England ☐
Italy ☐ Viet Nam ☐ Scotland ☐
Greece ☐ Other (please specify) ☐
4c) Are you of Aboriginal or Torres Strait Islander origin?

   No  □  Yes, Aboriginal □  Yes, Torres Strait Islander □  Yes, Aboriginal and Torres Strait Islander □

4d) Do you speak a language other than English at home? Please mark one box only. If more than one language other than English, mark the one that is spoken most often.

   No, English only □  Yes, Italian □  Yes, Greek □
   Yes, Cantonese □  Yes, Arabic □  Yes, Vietnamese □
   Yes, Mandarin □  Yes, Other (please specify) □

5a) How old were you when you finished full time education?

   Under 14 years □  14 - 16 years □  17 - 19 years □  20 years or older □

5b) What is the level of the highest educational qualification you have completed?

   Secondary school up to Year 10 or equivalent □  Secondary school Year 11- 12 or equivalent □
   Certificate or diploma (associate, undergraduate) □
   Undergraduate degree □  Postgraduate certificate or diploma □
   Masters degree or PhD □

5c) What is your current marital status?

   Married □  De Facto □  Separated □
   Single □  Divorced □  Widowed □

6a) How tall are you?

   □□□ cm or □ ft □ in

6b) What is your current weight?

   □□□ kg or □ st □ lbs

Please round off your weight and height to the nearest whole number. Do not use decimal points.
### TOBACCO SMOKING AND ALCOHOL CONSUMPTION

7a) Over your lifetime, would you have smoked as much as 100 cigarettes or a similar amount of tobacco? (If NO go to Question 8)

<table>
<thead>
<tr>
<th>No</th>
<th>Yes</th>
</tr>
</thead>
</table>

7b) Have you ever smoked regularly (ie at least once per day for a month or longer)? (If NO go to Question 8)

<table>
<thead>
<tr>
<th>No</th>
<th>Yes</th>
</tr>
</thead>
</table>

7c) If YES, do you still smoke regularly?

<table>
<thead>
<tr>
<th>No</th>
<th>Yes</th>
</tr>
</thead>
</table>

7d) If you NO longer smoke regularly when did you stop? Please specify year

<table>
<thead>
<tr>
<th>Year</th>
</tr>
</thead>
</table>

If you have ever smoked regularly or currently smoke regularly, please complete the following:

7e) In total, how many years have you smoked?

<table>
<thead>
<tr>
<th>Years</th>
</tr>
</thead>
</table>

7f) Cigarettes (average number per day)

<table>
<thead>
<tr>
<th>Number</th>
</tr>
</thead>
</table>

7g) Pipe (grams of tobacco per day)

<table>
<thead>
<tr>
<th>Grams</th>
</tr>
</thead>
</table>

7h) Cigars (average number per week)

<table>
<thead>
<tr>
<th>Number</th>
</tr>
</thead>
</table>

8a) Do you drink alcohol?  
No ☐ If NO, please go to Question 9.

Yes ☐ If YES, please continue.

8b) Which of the following best describes how often you would have an alcoholic drink?

<table>
<thead>
<tr>
<th>Frequency</th>
</tr>
</thead>
</table>

8c) On a day that you would have an alcoholic drink, how many standard drinks would you usually have?

<table>
<thead>
<tr>
<th>Standard Drinks</th>
</tr>
</thead>
</table>

8d) How often would you have had more than 2 standard drinks in a day?

<table>
<thead>
<tr>
<th>Frequency</th>
</tr>
</thead>
</table>

The following are all equal to approximately one standard drink:
- Low strength beer (2.7% alcohol): 13 can or 7/5 'pots'; (volume 470ml)
- Mid strength beer light beer (3.5%): 1 can or 1 4/5 'pots' or 0.8 'stubby'; (volume 375ml)
- Full strength beer (4.9% includes diet beer): 0.9 'pots' or ¾ 'stubby'; (volume 260ml)
- Wine (9.5-13%): one small glass; (volume 100ml)
- Spirits / liqueurs (37-40%): one shot/hip; (volume 30ml)
- Mixed drinks: 1 glass; (volume 30ml of spirits + mixer)
- Pre-mixed spirits (5-7%): 1 1/3 can or 7/5 - 0.9 bottle; (volume 180-250 ml)
SECTION TWO: YOUR CURRENT WORK AND WELLBEING

9a) What is your main occupation? [Blank]

9b) What is your current employment status?
   - Full-time [Blank]
   - Part-time [Blank]
   - Casual [Blank]

9c) What hospital campus do you currently work at?
   - Alfred [Blank]
   - Caulfield [Blank]
   - Sandringham [Blank]

9d) Are you employed through a Nursing Agency or Nurse Bank?
   - No [Blank]
   - Yes [Blank]

10. How long have you done this job?
    - Less than 1 year [Blank]
    - 1 - 5 years [Blank]
    - More than 5 years [Blank]

11. How many hours per week do you normally work in this job? [Blank] Hours

12. Does an average working day in the job involve any of the following? (Please place a cross on No or Yes for each question)

   a) Use of a keyboard or typewriter for more than four hours in total? [No] [Yes]
   b) Other tasks involving repeated movements of the wrist or fingers for more than four hours in total? [No] [Yes]
   c) Repeated bending and straightening of your elbow for longer than one hour in total? [No] [Yes]
   d) Working for longer than one hour in total with your hands above shoulder height? [No] [Yes]
   e) Lifting weights of 25 Kg (56 lbs) or more by hand? [No] [Yes]
   f) Climbing up or down more than 30 flights of stairs a day? [No] [Yes]
   g) Kneeling or squatting for longer than one hour in total? [No] [Yes]
   h) Piecework in which you are paid according to the number of articles or tasks you or your team make or finish in the day? [No] [Yes]
   i) A target number of articles or tasks that you or your team are expected to make or finish in the day? [No] [Yes]
   j) Payment of a bonus if you make or finish more than an agreed number of articles/tasks in the day? [No] [Yes]
   k) Working under pressure to complete tasks by a fixed time? [No] [Yes]
13. In your job, do you have a choice in deciding:  
<table>
<thead>
<tr>
<th>Often</th>
<th>Sometimes</th>
<th>Seldom</th>
<th>Never/Almost Never</th>
</tr>
</thead>
</table>
   a) **How** you do your work?  
   b) **What** you do at work?  
   c) Your work timetable and breaks?  

14. When you have difficulties in your work, how often do you get help and support from your colleagues or supervisor/manager?  
<table>
<thead>
<tr>
<th>Often</th>
<th>Sometimes</th>
<th>Seldom</th>
<th>Never</th>
<th>Not applicable</th>
</tr>
</thead>
</table>

15. How satisfied have you been with your job as a whole, taking everything into consideration?  
<table>
<thead>
<tr>
<th>Very satisfied</th>
<th>Satisfied</th>
<th>Dissatisfied</th>
<th>Very dissatisfied</th>
</tr>
</thead>
</table>

16. How secure do you feel your job would be if you had a significant illness that kept you off work for three months?  
<table>
<thead>
<tr>
<th>Very safe</th>
<th>Safe</th>
<th>Rather unsafe</th>
<th>Very unsafe</th>
</tr>
</thead>
</table>

17. Do you have any other job(s)?  
<table>
<thead>
<tr>
<th>No</th>
<th>Yes</th>
</tr>
</thead>
</table>
   If **YES**, what are your other job(s)?  
   

18. In general, would you say your health is:  
<table>
<thead>
<tr>
<th>Excellent</th>
<th>Very good</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
</table>
19. The following questions are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?
   a) Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf
   b) Climbing several flights of stairs

20. During the past 4 weeks, how much of the time have you had any of the following problems with your work or other regular daily activities as a result of your physical health?
   a) Accomplished less than you would like
   b) Were limited in the kind of work or other activities

21. During the past 4 weeks, how much of the time have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?
   a) Accomplished less than you would like
   b) Did work or activities less carefully than usual

22. During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?
   Not at all  □  A little bit  □  Moderately  □  Quite a bit  □  Extremely  □

23. These questions are about how you feel and how things have been with you during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the past 4 weeks...
   a) Have you felt calm and peaceful?
   b) Did you have a lot of energy?
   c) Have you felt downhearted and depressed?

24. During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting friends, relatives, etc.)?
SECTION THREE: ACHEs AND PAINs

LOW BACK PAIN IN PAST 12 MONTHS

25 a) Have you had low back pain in the area shown below which lasted for more than a day at any time during the past 12 months?

(Do not include pain associated only with menstrual periods, pregnancy or during a course of a feverish illness.)

No ☐ Yes ☐

If NO, please go to question 30. If YES, please continue.

b) Within the past 12 months, has the pain ever spread down your leg(s) to below the knee (sciatica)?

No ☐ Yes ☐

c) If you add together all the days on which you have had low back pain, during the past 12 months, how long a period would that make?

1 - 6 days ☐ 1 - 4 weeks ☐ 1 - 12 months ☐

d) During the past 12 months on how many days did low back pain prevent you from going to work?

0 days ☐ 1 - 5 days ☐ 6 - 30 days ☐ More then 30 days ☐

e) Have you consulted a doctor or a medical person or alternative practitioner because of low back pain during the past 12 months?

No ☐ Yes ☐

f) If YES, what were you told was the cause of the pain or the diagnosis?

Muscle strain or soft tissue / ligament injury ☐ Slipped or prolapsed disc ☐ Arthritis ☐

Fracture ☐ Other, please specify ☐

26. Do you expect that your back pain will be a problem in 12 months time?

No ☐ Possibly ☐ Probably ☐ Definitely ☐
Appendix A

LOW BACK PAIN IN PAST MONTH

We are particularly interested in any back pain you may have had during the past month

27 a) Have you had low back pain in the area shown below which lasted for more than a day at any time during the past month?

(Do not include pain associated only with menstrual periods, pregnancy or during a course of a feverish illness.)

No ☐ Yes ☐

If NO, please go to question 30. If YES, please continue.

b) Within the past month, has the pain ever spread down your leg(s) to below the knee (sciatica)?

No ☐ Yes ☐

c) If you add together all the days on which you have had low back pain, during the past month, how long a period would that make?

1 - 6 days ☐ 1 - 2 weeks ☐ More than 2 weeks ☐

28. During the past month, has low back pain at any time made it difficult or impossible to do any of the following activities?

a) Cutting your toe nails ☐ Difficult ☐ Impossible ☐

b) Getting dressed ☐ Difficult ☐ Impossible ☐

c) Doing the jobs that you normally do around the house ☐ Difficult ☐ Impossible ☐

29. Please think back to the last time that you were free from low back pain for a month or longer. When your most recent episode of low back pain then started, how did it begin?

Suddenly (ie within less than a minute) while you were at work ☐

Suddenly (ie within less than a minute) but not while you were at work ☐

Gradually ☐

NECK PAIN IN PAST 12 MONTHS

30 a) Have you had pain in the neck in the area shown below which lasted for more than a day at any time during the past 12 months?

    No ☐   Yes ☐

If **NO**, please go to question 34. If **YES**, please continue.

b) If you add together all the days on which you have had neck pain, in the past 12 months, how long a period would that make?

    1 - 6 days ☐   1 - 4 weeks ☐   1 - 12 months ☐

c) During the past 12 months on how many days did neck pain prevent you from going to work?

    0 days ☐   1 - 5 days ☐   6 - 30 days ☐   More then 30 days ☐

d) Have you consulted a doctor or a medical person or alternative practitioner because of neck pain during the past 12 months?

    No ☐   Yes ☐

e) If **YES**, what were you told was the cause of the pain or the diagnosis?

    Muscle strain or soft tissue / ligament injury ☐   Arthritis ☐   Nerve compression or nerve injury ☐

    Fracture ☐   Other, please specify ☐

31. Do you expect that your neck pain will be a problem in 12 months time?

    No ☐   Possibly ☐   Probably ☐   Definitely ☐
NECK PAIN IN THE PAST MONTH

We are particularly interested in any neck pain you may have had during the past month.

32 a) Have you had pain in the neck in the area shown below which lasted for more than a day at any time during the past month?

No ☐ Yes ☐

If NO, please go to question 34. If YES, please continue.

b) If you add together all the days on which you have had neck pain, during the past month, how long a period would that make?

1 - 6 days ☐ 1 - 2 weeks ☐ More than 2 weeks ☐

33. During the past month, has neck pain at any time made it difficult or impossible to do any of the following activities?

a) Getting dressed

No ☐ Difficult ☐ Impossible ☐

b) Doing the jobs that you normally do around the house

No ☐ Difficult ☐ Impossible ☐
Appendix A

SHOULDER PAIN IN PAST 12 MONTHS

34 a) Have you had pain in the shoulder in the area shown below which lasted for more than a day at any time during the past 12 months?

No □ Right shoulder only □
Left shoulder only □ Both shoulders □

If NO, please go to question 38. If YES, please continue

b) If you add together all the days on which you have had shoulder pain, in the past 12 months, how long a period would that make?

1 - 6 days □ 1 - 4 weeks □ 1 - 12 months □

c) During the past 12 months on how many days did shoulder pain prevent you from going to work?

0 days □ 1 - 5 days □ 6 - 30 days □ More then 30 days □

d) Have you consulted a doctor or a medical person or alternative practitioner because of shoulder pain during the past 12 months?

No □ Yes □

e) If YES, what were you told was the cause of the pain or the diagnosis?

Muscle strain or soft tissue / ligament injury □ Arthritis □ Nerve compression or nerve injury □
Fracture □ Other, please specify □ ____________________________

35. Do you expect that your shoulder pain will be a problem in 12 months time?

No □ Possibly □ Probably □ Definitely □
Appendix A

SHOULDER PAIN IN THE PAST MONTH

We are particularly interested in any shoulder pain you may have had during the past month.

36 a) Have you had pain in the shoulder in the area shown below which lasted for more than a day at any time during the past month?

No [ ] Right shoulder only [ ]
Left shoulder only [ ] Both shoulders [ ]

If NO, please go to question 38. If YES, please continue.

36 c) If you add together all the days on which you have had shoulder pain, during the past month, how long a period would that make?

1 - 6 days [ ] 1 - 2 weeks [ ] More than 2 weeks [ ]

37. During the past month, has shoulder pain at any time made it difficult or impossible to do any of the following activities?

<table>
<thead>
<tr>
<th>Activity</th>
<th>No</th>
<th>Difficult</th>
<th>Impossible</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Combing or brushing your hair</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Bathing/Showering</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) Getting dressed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d) Doing the jobs that you normally do around the house</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ELBOW PAIN IN PAST 12 MONTHS

38 a) Have you had pain in the elbow in the area shown below which lasted for more than a day at any time during the past 12 months?

- No □
- Right elbow only □
- Left elbow only □
- Both elbows □

If NO, please go to question 42. If YES, please continue

b) If you add together all the days on which you have had elbow pain, in the past 12 months, how long a period would that make?

- 1 - 6 days □
- 1 - 4 weeks □
- 1 - 12 months □

c) During the past 12 months on how many days did elbow pain prevent you from going to work?

- 0 days □
- 1 - 5 days □
- 6 - 30 days □
- More than 30 days □

d) Have you consulted a doctor or a medical person or alternative practitioner because of elbow pain during the past 12 months?

- No □
- Yes □

e) If YES, what were you told was the cause of the pain or the diagnosis?

- Muscle strain or soft tissue / ligament injury □
- Arthritis □
- Nerve compression or nerve injury □
- Fracture □
- Other, please specify □

39. Do you expect that your elbow pain will be a problem in 12 months time?

- No □
- Possibly □
- Probably □
- Definitely □
Appendix A

ELBOW PAIN

ELBOW PAIN IN THE PAST MONTH

We are particularly interested in any elbow pain you may have had during the past month

40. a) Have you had pain in the elbow in the area shown below which lasted for more than a day at any time during the past month?

No ☐ Right elbow only ☐
Left elbow only ☐ Both elbows ☐

If NO, please go to question 42. If YES, please continue

b) If you add together all the days on which you have had elbow pain, during the past month, how long a period would that make?

1 - 6 days ☐ 1 - 2 weeks ☐ More than 2 weeks ☐

41. During the past month, has elbow pain at any time made it difficult or impossible to do any of the following activities?

<table>
<thead>
<tr>
<th>Activity</th>
<th>No</th>
<th>Difficult</th>
<th>Impossible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opening bottles, jars or taps</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Getting dressed</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Doing the jobs that you normally do around the house</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
WRIST AND HAND PAIN IN PAST 12 MONTHS

42 a) Have you had pain in the wrist or hand in the area shown below which lasted for more than a day at any time during the past 12 months?

- No □ Right wrist or hand only □
- Left wrist or hand only □ Both wrists or hands □

If NO, please go to question 46. If YES, please continue

b) If you add together all the days on which you have had wrist/hand pain, in the past 12 months, how long a period would that make?

- 1 - 6 days □
- 1 - 4 weeks □
- 1 - 12 months □

c) During the past 12 months on how many days did wrist/hand pain prevent you from going to work?

- 0 days □
- 1 - 5 days □
- 6 - 30 days □
- More than 30 days □

d) Have you consulted a doctor or a medical person or alternative practitioner because of wrist/hand pain during the past 12 months?

- No □ Yes □

e) If YES, what were you told was the cause of the pain or the diagnosis?

- Muscle strain or soft tissue / ligament injury □
- Arthritis □
- Nerve compression or nerve injury □
- Fracture □
- Other, please specify □

43. Do you expect that your wrist/hand pain will be a problem in 12 months time?

- No □ Possibly □
- Probably □ Definitely □
WRIST AND HAND PAIN IN THE PAST MONTH

We are particularly interested in any wrist/hand pain you may have had during the past month.

44 a) Have you had pain in the wrist or hand in the area shown below which lasted for more than a day at any time during the past month?

- No □  Right wrist or hand only □
- Left wrist or hand only □  Both wrists or hands □

If NO, please go to question 46. If YES, please continue.

b) If you add together all the days on which you have had wrist/hand pain, during the past month, how long a period would that make?

- 1 - 6 days □  1 - 2 weeks □  More than 2 weeks □

45. During the past month, has wrist/hand pain at any time made it difficult or impossible to do any of the following activities?

<table>
<thead>
<tr>
<th>Activity</th>
<th>No</th>
<th>Difficult</th>
<th>Impossible</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Writing</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>b) Locking and unlocking doors</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>c) Opening bottles, jars or taps</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>d) Getting dressed</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>e) Doing the jobs that you normally do around the house</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>
Appendix A

KNEE PAIN

46 a) Have you had pain in the knee in the area shown below which lasted for more than a day at any time during the past 12 months?

No □ Right knee only □
Left knee only □ Both knees □

If NO, please go to question 50. If YES, please continue

b) If you add together all the days on which you have had knee pain, in the past 12 months, how long a period would that make?

1 - 6 days □ 1 - 4 weeks □ 1 - 12 months □

c) During the past 12 months on how many days did knee pain prevent you from going to work?

0 days □ 1 - 5 days □ 6 - 30 days □ More than 30 days □

d) Have you consulted a doctor or a medical person or alternative practitioner because of knee pain during the past 12 months?

No □ Yes □

e) If YES, what were you told was the cause of the pain or the diagnosis?

Muscle strain or soft tissue / ligament injury □ Arthritis □ Nerve compression or nerve injury □
Fracture □ Other, please specify □

47. Do you expect that your knee pain will be a problem in 12 months time?

No □ Possibly □ Probably □ Definitely □
## KNEE PAIN IN THE PAST MONTH

We are particularly interested in any knee pain you may have had during the past month.

48 a) Have you had pain in the knee in the area shown below which lasted for more than a day at any time during the past month?

- **No**  
- **Right knee only**  
- **Left knee only**  
- **Both knees**

If **NO**, please go to question 50. If **YES**, please continue.

---

48 b) If you add together all the days on which you have had knee pain, during the past month, how long a period would that make?

- **1 - 6 days**  
- **1 - 2 weeks**  
- **More than 2 weeks**

---

49. During the past month, has knee pain at any time made it difficult or impossible to do any of the following activities?

<table>
<thead>
<tr>
<th>Activity</th>
<th>No</th>
<th>Difficult</th>
<th>Impossible</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Walking up and down stairs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Walking on level ground</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) Getting dressed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d) Doing the jobs that you normally do around the house</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
SECTION FOUR: OTHER PEOPLE’S PAIN

LOW BACK PAIN

50. Do you know anyone who has had low back pain in the past 12 months?
   a) At work
      No  Yes
   b) Outside work
      No  Yes

NECK PAIN

51. Do you know anyone who has had neck pain in the past 12 months?
   a) At work
      No  Yes
   b) Outside work
      No  Yes

PAIN IN THE ARM, SHOULDER OR HAND

52. Do you know anyone who has had pain in the arm, shoulder or hand in the past 12 months?
   a) At work
      No  Yes
   b) Outside work
      No  Yes

KNEE PAIN

53. Do you know anyone who has had knee pain in the past 12 months?
   a) At work
      No  Yes
   b) Outside work
      No  Yes
### SECTION FIVE: YOUR VIEWS ON THE CAUSES AND PREVENTION OF PAIN

54. Based on your own views and what the doctor or others may have told you about pain in the arm, shoulder or hands, how strongly do you agree with the following statements? *(Place a cross in one box on each line.)*

<table>
<thead>
<tr>
<th>For someone with this problem ...</th>
<th>Completely disagree</th>
<th>Tend to disagree</th>
<th>Unsure</th>
<th>Tend to agree</th>
<th>Completely agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical activity should be avoided as it might harm the arm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>These problems usually get better within three months</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rest is needed to get better</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neglecting problems of this kind can cause permanent health problems</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>These problems are commonly caused by people’s work</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

55. Based on your own views and what the doctor or others may have told you about low-back pain, how strongly do you agree with the following statements? *(Place a cross in one box on each line.)*

<table>
<thead>
<tr>
<th>For someone with this problem ...</th>
<th>Completely disagree</th>
<th>Tend to disagree</th>
<th>Unsure</th>
<th>Tend to agree</th>
<th>Completely agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical activity should be avoided as it might harm the back</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>These problems usually get better within three months</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rest is needed to get better</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neglecting problems of this kind can cause permanent health problems</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>These problems are commonly caused by people’s work</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

56. Have you ever heard or read about repetitive strain injury (RSI), work related upper limb disorder (WRULD) or cumulative trauma syndrome (CTS)?

No ☐ Yes ☐
# Appendix A

## YOUR HEALTH MORE GENERALLY

### SECTION SIX: YOUR HEALTH MORE GENERALLY

#### PAST 7 DAYS

57. Below is a list of problems people sometimes have. Please read each one carefully and place a cross in the box that best describes HOW MUCH THAT PROBLEM HAS DISTRESSED OR BOTHERED YOU DURING THE **PAST 7 DAYS INCLUDING TODAY**

Place a cross in **only one box** for each problem and do not skip any items

<table>
<thead>
<tr>
<th></th>
<th>Not at all</th>
<th>A little bit</th>
<th>Moderately</th>
<th>Quite a bit</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Faintness or dizziness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Pains in the heart or chest</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>c) Nausea or upset stomach</td>
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</tr>
<tr>
<td>d) Trouble getting your breath</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>e) Numbness or tingling in parts of your body</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f) Feeling weak in parts of your body</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g) Hot or cold spells</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix A

YOUR HEALTH MORE GENERALLY

PAST MONTH

58. These questions are about how you feel and how things have been with you during the past month. For each question, please give the one answer that best describes how things have been for you during the past month. How much of the time during the past month.

Place a cross in only one box on each line.

<table>
<thead>
<tr>
<th></th>
<th>All of the time</th>
<th>Most of the time</th>
<th>A good bit of the time</th>
<th>Some of the time</th>
<th>A little of the time</th>
<th>None of the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Were you a happy person?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Have you felt calm and peaceful?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) Have you been a very nervous person?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d) Have you felt downhearted and low?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e) Have you felt so down that nothing could cheer you up?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PAST 12 MONTHS

59. Over the past 12 months, on how many days in total have you been prevented from going to work because of

a) a problem with your back, neck, shoulder, elbow, wrist, hand or knees

   0 days □  1 - 5 days □  6 - 30 days □  More than 30 days □

b) other illness

   0 days □  1 - 5 days □  6 - 30 days □  More than 30 days □
SECTION SEVEN: GENERAL HEALTH AND RESILIENCE

60. Please indicate how much you agree with the following statements as they apply to you over the last MONTH. If a particular situation has not occurred recently, answer according to how you think you would have felt.

<table>
<thead>
<tr>
<th></th>
<th>Not true at all</th>
<th>Rarely True</th>
<th>Sometimes True</th>
<th>Often True</th>
<th>True nearly all the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) I am able to adapt when changes occur.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) I can deal with whatever comes my way.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) I try to see the humorous side of things when I am faced with problems.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d) Having to cope with stress can make me stronger.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e) I tend to bounce back after illness, injury or other hardships.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f) I believe I can achieve my goals, even if there are obstacles.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g) Under pressure, I stay focused and think clearly.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h) I am not easily discouraged by failure.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i) I think of myself as a strong person when dealing with life’s challenges and difficulties.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>j) I am able to handle pleasant or painful feelings like sadness, fear and anger.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
61. We should like to know if you have had any medical complaints, and how your health has been in general, over the past few weeks. Please answer ALL the questions simply by placing a cross in the box which you think most nearly applies to you. Remember that we want to know about present and recent complaints, not those you had in the past. It is important that you try to answer ALL the questions.

We would like to know how you have been feeling over the past few weeks.

Please place a cross in the box that most closely describes your experience for each question

a) Have you recently been able to concentrate on whatever you’re doing?
   Better than usual ☐  Same as usual ☐  Less than usual ☐  Much less than usual ☐

b) Have you recently lost much sleep over worry?
   Not at all ☐  No more than usual ☐  Rather more than usual ☐  Much more than usual ☐

c) Have you recently felt that you are playing a useful part in things?
   More so than usual ☐  Same as usual ☐  Less useful than usual ☐  Much less useful ☐

d) Have you recently felt capable of making decisions about things?
   More so than usual ☐  Same as usual ☐  Less so than usual ☐  Much less capable ☐

e) Have you recently felt constantly under strain?
   Not at all ☐  No more than usual ☐  Rather more than usual ☐  Much more than usual ☐

f) Have you recently felt you couldn't overcome your difficulties?
   Not at all ☐  No more than usual ☐  Rather more than usual ☐  Much more than usual ☐
Appendix A

GENERAL HEALTH AND RESILIENCE

g) Have you recently been able to enjoy your normal day-to-day activities?
   More so than usual  □   Same as usual  □   Less so than usual  □   Much less than usual  □

h) Have you recently been able to face up to your problems?
   More so than usual  □   Same as usual  □   Less able than usual  □   Much less able  □

i) Have you recently been feeling unhappy and depressed?
   Not at all  □   No more than usual  □   Rather more than usual  □   Much more than usual  □

j) Have you recently been losing confidence in yourself?
   Not at all  □   No more than usual  □   Rather more than usual  □   Much more than usual  □

k) Have you recently been thinking of yourself as a worthless person?
   Not at all  □   No more than usual  □   Rather more than usual  □   Much more than usual  □

l) Have you recently been feeling reasonably happy, all things considered?
   More so than usual  □   About same as usual  □   Less so than usual  □   Much less than usual  □
## SECTION EIGHT: YOUR PERCEPTIONS OF PAIN

62. Everyone experiences painful situations at some point in their lives. Such experiences may include headaches, tooth pain, joint or muscle pain. People are often exposed to situations that may cause pain such as illness, injury, dental procedures or surgery.

**Instructions:**
We are interested in the types of thoughts and feelings that you have when you are in pain. Listed below are thirteen statements describing different thoughts and feelings that may be associated with pain. Using the following scale, please indicate the degree to which you have these thoughts and feelings when you are experiencing pain.

<table>
<thead>
<tr>
<th>When I'm in pain ...</th>
<th>Not at all</th>
<th>To a slight degree</th>
<th>To a moderate degree</th>
<th>To a great degree</th>
<th>All the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) I worry all the time about whether the pain will end.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>b) I feel I can't go on.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>c) It's terrible and I think it's never going to get any better.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>d) It's awful and I feel that it overwhels me.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>e) I feel I can't stand it anymore.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>f) I become afraid that the pain will get worse.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>g) I keep thinking of other painful events.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>h) I anxiously want the pain to go away.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>i) I can't seem to keep it out of my mind.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>j) I keep thinking about how much it hurts.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>k) I keep thinking about how badly I want the pain to stop.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>l) There's nothing I can do to reduce the intensity of the pain.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>m) I wonder whether something serious may happen.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

63. We are trying to find out what people think about back trouble. Please indicate your general views towards **back trouble**, even if you have never had any.

Please indicate whether you agree or disagree with each statement on a scale of 1 to 5, where 1 is completely disagree and 5 is completely agree, by marking a cross in one box on each line.

<table>
<thead>
<tr>
<th>Statement</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) There is no real treatment for back trouble</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Back trouble will eventually stop you from working</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>c) Back trouble means periods of pain for the rest of one’s life</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d) Doctors cannot do anything for back trouble</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e) A bad back should be exercised</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f) Back trouble makes everything in life worse</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g) Surgery is the most effective way to treat back trouble</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h) Back trouble may mean you end up in a wheelchair</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i) Alternative treatments are the answer to back trouble</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>j) Back trouble means long periods of time off work</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>k) Medication is the only way of relieving back trouble</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>l) Once you’ve had back trouble there is always a weakness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>m) Back trouble must be rested</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n) Later in life back trouble gets progressively worse</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Smyonds TL, Burton AK, Takkston KM, et al. Absence resulting from low back trouble can be reduced by psychosocial intervention at the work place, Spine 1995;20:2738–44.
Appendix A

We appreciate that your time is valuable and thank you very much for your contribution to this important study.

Please return this questionnaire in the prepaid envelope provided.
Appendix B

B: Australian Nurses’ Work and Health Study follow-up questionnaire
Australian Nurses’ Work and Health Study

FOLLOW-UP QUESTIONNAIRE
2010

Australian arm of the CUPID Study
International Survey of Physical, Cultural and Psychosocial Influences on Musculoskeletal Symptoms and Associated Disability

MONASH Centre for Occupational and Environmental Health
Appendix B

Please read the following instructions regarding the completion of this questionnaire.
When completing the questionnaire please place a cross ☑ in the boxes corresponding to your answer. Please DO NOT circle the box ☐ or mark outside the box.
Fill in with text and numbers where appropriate. Use a blue or black pen.
If you make a mistake or want to change your answer please use correction fluid and mark the correct box.
Please ring the Study team if you are unsure about how to complete any section of this questionnaire. The free call number is 1800 818 765.

Please fill in the date that you complete this form

Date: ☐ ☐ ☐

day

month

year

Please fill in your details

Surname (in capitals): ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Other name(s): ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

State: ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Post code: ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Note: to ensure confidentiality of your information, this page will be removed by the Monash University Study team and stored separately from the rest of the questionnaire.
Appendix B

SECTION ONE: ABOUT YOURSELF

1. Please fill in your date of birth
   Date: ___________ ___________ ___________
day       month       year

2. and your sex
   Male      Female

3. What is your current marital status?
   Married    | De Facto | Separated
   Single     | Divorced | Widowed

4. What is your current weight? ___________ kg (round off to nearest whole number, do not include decimal point)

5. What is your current smoking status?
   Never smoked | Currently still smoking | Stopped smoking

6 a) Do you drink alcohol?
   No      Yes

   If YES, please continue. If NO, please go to Question 7

   The following are all equal to approximately one standard drink:
   Low strength beer (2.7% alcohol): 1½ can or 1 ½ ‘pots’; (volume 470ml)
   Mid strength beer light beer (3.5%): 1 can or 1 ⅔ ‘pots’ or 0.8 ‘stubby’; (volume 375ml)
   Full strength beer (4.9%)(includes diet beer): 0.9 ‘pots’ or ¾ ‘stubby’; (volume 260ml)
   Wine (9.5-13%): one small glass; (volume 100ml)
   Spirits / liqueurs (37-40%): one shot/nip; (volume 30ml)
   Mixed drinks: 1 glass; (volume 30ml of spirits + mixer)
   Pre-mixed spirits (5-7%): ½ - ½½ can or ½½ - 0.9 bottle; (volume 180-250 ml)

6 b) On a day that you would have an alcoholic drink, how many standard drinks would you usually have?
   13 or more standard drinks | 11 - 12 standard drinks | 7 - 10 standard drinks
   5 - 6 standard drinks      | 3 - 4 standard drinks   | 1 - 2 standard drinks

6 c) How often would you have had more than 2 standard drinks in a day?
   Everyday | 4 - 6 days a week | 2 - 3 days a week
   About 1 day a week   | 2 - 3 days a month | About 1 day a month
   Less often | Never

Please turn over to next page
Appendix B

SECTION TWO: YOUR WORK AND WELLBEING

7. How long have you been in the Nursing profession? __ year(s) __ month(s)

8 a) Which was the main hospital that you worked at in the past 12 months?

The Alfred ☐ Caulfield ☐ Sandringham ☐ I have not been working in these hospitals in the past 12 months (Please go to question 14) ☐

8 b) What was your main employment status in the hospital in the past 12 months?

Full-time ☐ Part-time ☐ Casual ☐

8 c) What was your main role or area in which you worked in the hospital above in the past 12 months?

Management ☐ General ward / Specialist ward ☐ Critical care ward (e.g. ICU/CCU) ☐
Clinics/ Outpatient ☐ Operating theatre/ Scrub nurse ☐ Field work/ Community nursing ☐
Research ☐ Emergency ward/ Emergency care ☐ Teaching/ Educator ☐
Administration ☐ Other, please specify ☐

8 d) How many hours per week do you normally work in this job? __________ hours/week

9. Does an average working day in the job involve any of the following? (Please place a cross on No or Yes for each question)

   a) Use of a keyboard or typewriter for more than four hours in total? ☐ ☐
   b) Other tasks involving repeated movements of the wrist or fingers for more than four hours in total? ☐ ☐
   c) Repeated bending and straightening of your elbow for longer than one hour in total? ☐ ☐
   d) Working for longer than one hour in total with your hands above shoulder height? ☐ ☐
   e) Lifting weights of 25 Kg (56 lbs) or more by hand? ☐ ☐
   f) Climbing up or down more than 30 flights of stairs a day? ☐ ☐
   g) Kneeling or squatting for longer than one hour in total? ☐ ☐
   h) Working under pressure to complete tasks by a fixed time? ☐ ☐
Appendix B

YOUR WORK AND WELLBEING

10. In your job, do you have a choice in deciding:  
   
<table>
<thead>
<tr>
<th>Often</th>
<th>Sometimes</th>
<th>Seldom</th>
<th>Never/Almost Never</th>
</tr>
</thead>
</table>
   a) How you do your work?   |
   b) What you do at work?   |
   c) Your work timetable and breaks?   |

11. When you have difficulties in your work, how often do you get help and support from your colleagues or supervisor/manager?  
   
<table>
<thead>
<tr>
<th>Often</th>
<th>Sometimes</th>
<th>Seldom</th>
<th>Never</th>
<th>Not applicable</th>
</tr>
</thead>
</table>

12. How satisfied have you been with your job as a whole, taking everything into consideration?  
   
<table>
<thead>
<tr>
<th>Very satisfied</th>
<th>Satisfied</th>
<th>Dissatisfied</th>
<th>Very dissatisfied</th>
</tr>
</thead>
</table>

13. How secure do you feel your job would be if you had a significant illness that kept you off work for three months?  
   
<table>
<thead>
<tr>
<th>Very safe</th>
<th>Safe</th>
<th>Rather unsafe</th>
<th>Very unsafe</th>
</tr>
</thead>
</table>

14 a) Do you still have the same main job as when we last questioned you about a year ago?  
   
   No   | Yes |
   |-----|-----|
   If YES, please go to question 15. If NO, please continue

   b) Did you leave that job because of medical problems with your back, neck, shoulder, elbow, wrist, hand or knee?  
   
   No   | Yes |
   |-----|-----|

   c) And do you have another job now?  
   
   No   | Yes |
   |-----|-----|

15. In general, would you say your health is:  
   
   Excellent   | Very good | Good | Fair | Poor |
   |-------------|-----------|------|-----|-----|

16. The following questions are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?  
   
<table>
<thead>
<tr>
<th>Yes, limited a lot</th>
<th>Yes, limited a little</th>
<th>No, not limited at all</th>
</tr>
</thead>
</table>
   a) Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf  
   
   b) Climbing several flights of stairs  
   
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>---------------------</td>
<td>-----------------------</td>
<td>------------------------</td>
</tr>
</tbody>
</table>
17. During the **past 4 weeks**, have you had any of the following problems with your work or other regular daily activities **as a result of your physical health**?

<table>
<thead>
<tr>
<th></th>
<th>All of the time</th>
<th>Most of the time</th>
<th>Some of the time</th>
<th>A little of the time</th>
<th>None of the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Accomplished less than you would like</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>b) Were limited in the kind of work or other activities</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

18. During the **past 4 weeks**, have you had any of the following problems with your work or other regular daily activities **as a result of any emotional problems** (such as feeling depressed or anxious)?

<table>
<thead>
<tr>
<th></th>
<th>All of the time</th>
<th>Most of the time</th>
<th>Some of the time</th>
<th>A little of the time</th>
<th>None of the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Accomplished less than you would like</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>b) Did work or activities less carefully than usual</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

19. During the **past 4 weeks**, how much did pain interfere with your normal work (including both work outside the home and housework)?

Not at all □  A little bit □  Moderately □  Quite a bit □  Extremely □

20. These questions are about how you feel and how things have been with you **during the past 4 weeks**. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the **past 4 weeks**...

<table>
<thead>
<tr>
<th></th>
<th>All of the time</th>
<th>Most of the time</th>
<th>Some of the time</th>
<th>A little of the time</th>
<th>None of the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Have you felt calm and peaceful?</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>b) Did you have a lot of energy?</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>c) Have you felt downhearted and depressed?</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

21. During the **past 4 weeks**, how much of the time has your **physical health or emotional problems** interfered with your social activities (like visiting with friends, relatives, etc.)?

All of the time □  Most of the Time □  Some of the time □  A little of the time □  None of the time □
SECTION THREE: ACHES AND PAINS

LOW BACK PAIN IN PAST MONTH

22a) Have you had low back pain in the area shown below which lasted for more than a day at any time during the past month? (Do not include pain associated only with menstrual periods, pregnancy or during a course of a feverish illness.)

No ☐ Yes ☐

If NO, please go to question 26. If YES, please continue.

b) If you add together all the days on which you have had low back pain, during the past month, how long a period would that make?

1-6 days ☐ 1-2 weeks ☐ More than 2 weeks ☐

c) Have you consulted a doctor or a medical person or alternative practitioner because of low back pain during the past month?

No ☐ Yes ☐

23. During the past month, has low back pain at any time made it difficult or impossible to do any of the following activities?

<table>
<thead>
<tr>
<th>No</th>
<th>Difficult</th>
<th>Impossible</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Cutting your toe nails</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>b) Getting dressed</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>c) Doing the jobs that you normally do around the house</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

24. During the past month on how many days has low back pain prevented you from going to work?

<table>
<thead>
<tr>
<th>0 days</th>
<th>1-5 days</th>
<th>More than 5 days</th>
<th>Not applicable because unemployed</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

25. Within the past month, has the pain ever spread down your leg(s) to below the knee (sciatica)?

No ☐ Yes ☐

LOW BACK PAIN IN PAST 12 MONTHS

26a) Have you had low back pain which lasted for more than a day at any time during the past 12 months? (Do not include pain associated only with menstrual periods, pregnancy or during a course of a feverish illness.)

No ☐ Yes ☐

If NO, please go to question 27. If YES, please continue.

b) If you add together all the days on which you have had low back pain, during the past 12 months, how long a period would that make?

1-6 days ☐ 1-4 weeks ☐ 1-12 months ☐

c) During the past 12 months on how many days did low back pain prevent you from going to work?

<table>
<thead>
<tr>
<th>0 days</th>
<th>1-5 days</th>
<th>6-30 days</th>
<th>More than 30 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Please turn over to next page
NECK PAIN IN THE PAST MONTH

27a) Have you had pain in the neck in the area shown below which lasted for more than a day at any time during the past month?

   No ☐       Yes ☐

   If NO, please go to question 30. If YES, please continue.

b) If you add together all the days on which you have had neck pain, during the past month, how long a period would that make?

   1-6 days ☐   1-2 weeks ☐   More than 2 weeks ☐

c) Have you consulted a doctor or a medical person or alternative practitioner because of neck pain during the past month?

   No ☐       Yes ☐

28. During the past month, has neck pain at any time made it difficult or impossible to do any of the following activities?

   Getting dressed ☐ ☐ ☐
   Doing the jobs that you normally do around the house ☐ ☐ ☐

29. During the past month on how many days has neck pain prevented you from going to work?

   0 days ☐   1-5 days ☐   More than 5 days ☐   Not applicable because unemployed ☐

NECK PAIN IN PAST 12 MONTHS

30a) Have you had neck pain which lasted for more than a day at any time during the past 12 months?

   No ☐       Yes ☐

   If NO, please go to question 31. If YES, please continue.

b) If you add together all the days on which you have had neck pain, during the past 12 months, how long a period would that make?

   1-6 days ☐   1-4 weeks ☐   1-12 months ☐

c) During the past 12 months on how many days did neck pain prevent you from going to work?

   0 days ☐   1-5 days ☐   6-30 days ☐   More than 30 days ☐
Appendix B

SHOULDER PAIN

SHOULDER PAIN IN THE PAST MONTH

31a) Have you had pain in the shoulder in the area shown below which lasted for more than a day at any time during the past month?

No ☐ Right shoulder only ☐

Left shoulder only ☐ Both shoulders ☐

If NO, please go to question 34. If YES please continue.

b) If you add together all the days on which you have had shoulder pain, during the past month, how long a period would that make?

1-6 days ☐ 1-2 weeks ☐ More than 2 weeks ☐

c) Have you consulted a doctor or a medical person or alternative practitioner because of shoulder pain during the past month?

No ☐ Yes ☐

32. During the past month, has shoulder pain at any time made it difficult or impossible to do any of the following activities?

a) Combing or brushing your hair ☐ ☐ ☐

b) Bathing/showering ☐ ☐ ☐

c) Getting dressed ☐ ☐ ☐

d) Doing the jobs that you normally do around the house ☐ ☐ ☐

33. During the past month on how many days has shoulder pain prevented you from going to work?

0 days ☐ 1-5 days ☐ More than 5 days ☐ Not applicable because unemployed ☐

SHOULDER PAIN IN PAST 12 MONTHS

34a) Have you had shoulder pain which lasted for more than a day at any time during the past 12 months?

No ☐ Right shoulder only ☐ Left shoulder only ☐ Both shoulders ☐

If NO, please go to question 35. If YES, please continue.

b) If you add together all the days on which you have had shoulder pain, during the past 12 months, how long a period would that make?

1-6 days ☐ 1-4 weeks ☐ 1-12 months ☐

c) During the past 12 months on how many days did shoulder pain prevent you from going to work?

0 days ☐ 1-5 days ☐ 6-30 days ☐ More than 30 days ☐
ELBOW PAIN IN THE PAST MONTH

35 a) Have you had pain in the elbow in the area shown below which lasted for more than a day at any time during the past month?

No □ Right elbow only □
Left elbow only □ Both elbows □

If NO, please go to question 38. If YES please continue.

b) If you add together all the days on which you have had elbow pain, during the past month, how long a period would that make?

1-6 days □ 1-2 weeks □ More than 2 weeks □

36. During the past month, has elbow pain at any time made it difficult or impossible to do any of the following activities?

No □ Difficult □ Impossible □

a) Opening bottles, jars or taps □ □ □

b) Getting dressed □ □ □

c) Doing the jobs that you normally do around the house □ □ □

37. During the past month on how many days has elbow pain prevented you from going to work?

0 days □ 1-5 days □ More than 5 days □ Not applicable because unemployed □

ELBOW PAIN IN PAST 12 MONTHS

38 a) Have you had elbow pain which lasted for more than a day at any time during the past 12 months?

No □ Right elbow only □ Left elbow only □ Both elbows □

If NO, please go to question 39. If YES, please continue.

b) If you add together all the days on which you have had elbow pain, during the past 12 months, how long a period would that make?

1-6 days □ 1-4 weeks □ 1-12 months □

c) During the past 12 months on how many days did elbow pain prevent you from going to work?

0 days □ 1-5 days □ 6-30 days □ More than 30 days □
Appendix B

WRIST OR HAND PAIN

WRIST AND HAND PAIN IN THE PAST MONTH

39 a) Have you had pain in the wrist or hand in the area shown below which lasted for more than a day at any time during the past month?

No □ Right hand or wrist only □

Left hand or wrist only □ Both hands or wrists □

If NO, please go to question 42. If YES please continue.

b) If you add together all the days on which you have had wrist/hand pain, during the past month, how long a period would that make?

1-6 days □ 1-2 weeks □ More than 2 weeks □

c) Have you consulted a doctor or a medical person or alternative practitioner because of wrist or hand pain during the past month?

No □ Yes □

40. During the past month, has wrist/hand pain at any time made it difficult or impossible to do any of the following activities?

a) Writing No □ Difficult □ Impossible □

b) Locking and unlocking doors No □ Difficult □ Impossible □

c) Opening bottles, jars or taps No □ Difficult □ Impossible □

d) Getting dressed No □ Difficult □ Impossible □

e) Doing the jobs that you normally do around the house No □ Difficult □ Impossible □

41. During the past month on how many days has wrist/hand pain prevented you from going to work?

0 days □ 1-5 days □ More than 5 days □ Not applicable because unemployed □

WRIST PAIN IN PAST 12 MONTHS

42 a) Have you had wrist or hand pain which lasted for more than a day at any time during the past 12 months?

No □ Right wrist only □ Left wrist only □ Both wrists □

If NO, please go to question 43. If YES, please continue.

b) If you add together all the days on which you have had wrist or hand pain, during the past 12 months, how long a period would that make?

1-6 days □ 1-4 weeks □ 1-12 months □

c) During the past 12 months on how many days did wrist or hand pain prevent you from going to work?

0 days □ 1-5 days □ 6-30 days □ More than 30 days □
Appendix B

KNEE PAIN

KNEE PAIN IN THE PAST MONTH

43 a) Have you had pain in the knee in the area shown below which lasted for more than a day at any time during the past month?

[Diagram of knee]

No ☐ Right knee only ☐
Left knee only ☐ Both knees ☐

If NO, please go to question 46. If YES please continue.

b) If you add together all the days on which you have had knee pain, during the past month, how long a period would that make?

1-6 days ☐ 1-2 weeks ☐ More than 2 weeks ☐

c) Have you consulted a doctor or a medical person or alternative practitioner because of knee pain during the past month?

No ☐ Yes ☐

44. During the past month, has knee pain at any time made it difficult or impossible to do any of the following activities?

<table>
<thead>
<tr>
<th>Activity</th>
<th>No ☐</th>
<th>Difficult ☐</th>
<th>Impossible ☐</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Walking up and down stairs</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>b) Walking on level ground</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>c) Getting dressed</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>d) Doing the jobs that you normally do around the house</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

45. During the past month on how many days has knee pain prevented you from going to work?

<table>
<thead>
<tr>
<th>Days</th>
<th>No ☐</th>
<th>1-5 days ☐</th>
<th>More than 5 days ☐</th>
<th>Not applicable ☐</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 days</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>1-5 days</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>More than 5 days</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Not applicable because unemployed</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

KNEE PAIN IN PAST 12 MONTHS

46 a) Have you had knee pain which lasted for more than a day at any time during the past 12 months?

No ☐ Right knee only ☐ Left knee only ☐ Both knees ☐

If NO, please go to question 47. If YES, please continue.

b) If you add together all the days on which you have had knee pain, during the past 12 months, how long a period would that make?

1-6 days ☐ 1-4 weeks ☐ 1-12 months ☐

c) During the past 12 months on how many days did knee pain prevent you from going to work?

<table>
<thead>
<tr>
<th>Days</th>
<th>No ☐</th>
<th>1-5 days ☐</th>
<th>6-30 days ☐</th>
<th>More than 30 days ☐</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 days</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>1-5 days</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
# SECTION FOUR: YOUR HEALTH MORE GENERALLY

## PAST 7 DAYS

47. Below is a list of problems people sometimes have. Please read each one carefully and place a cross in the box that best describes HOW MUCH THAT PROBLEM HAS DISTRESSED OR BOTHERED YOU DURING THE **PAST 7 DAYS INCLUDING TODAY**

*Place a cross in only one box for each problem and do not skip any items*

<table>
<thead>
<tr>
<th>Not at all</th>
<th>A little bit</th>
<th>Moderately</th>
<th>Quite a bit</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Faintness or dizziness</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Pains in the heart or chest</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) Nausea or upset stomach</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d) Trouble getting your breath</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e) Numbness or tingling in parts of your body</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f) Feeling weak in parts of your body</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g) Hot or cold spells</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### PAST MONTH

48. These questions are about how you feel and how things have been with you **during the past month**. For each question, please give the one answer that best describes how things have been for you during the past month. How much of the time during the **past month**:

   *Place a cross in one box on each line.*

<table>
<thead>
<tr>
<th>All of the time</th>
<th>Most of the time</th>
<th>A good bit of the time</th>
<th>Some of the time</th>
<th>A little of the time</th>
<th>None of the time</th>
</tr>
</thead>
</table>

a) Were you a happy person?  

b) Have you felt calm and peaceful?  

c) Have you been a very nervous person?  

d) Have you felt downhearted and low?  

e) Have you felt so down that nothing could cheer you up?  

### PAST 12 MONTHS

49. Over the past 12 months, on how many days in total have you been prevented from going to work because of

a) a problem with your back, neck, shoulder, elbow, wrist, hand or knees

   - 0 days  
   - 1-5 days  
   - 6-30 days  
   - More than 30 days  

b) other illness

   - 0 days  
   - 1-5 days  
   - 6-30 days  
   - More than 30 days  

Appendix B

YOUR HEALTH MORE GENERALLY

50. Please indicate how much you agree with the following statements as they apply to you over the last MONTH. If a particular situation has not occurred recently, answer according to how you think you would have felt.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Not true at all</th>
<th>Rarely true</th>
<th>Sometimes true</th>
<th>Often true</th>
<th>True nearly all the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) I am able to adapt when changes occur.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>b) I can deal with whatever comes my way.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>c) I try to see the humourous side of things when I am faced with problems.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>d) Having to cope with stress can make me stronger.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>e) I tend to bounce back after illness, injury or other hardships.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>f) I believe I can achieve my goals, even if there are obstacles.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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</tr>
<tr>
<td>g) Under pressure, I stay focused and think clearly.</td>
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<td>☐</td>
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</tr>
<tr>
<td>h) I am not easily discouraged by failure.</td>
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<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>i) I think of myself as a strong person when dealing with life’s challenges and difficulties.</td>
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<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>j) I am able to handle unpleasant or painful feelings like sadness, fear and anger.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
Appendix B

YOUR HEALTH MORE GENERALLY

51. We should like to know if you have had any medical complaints, and how your health has been in general, over the past few weeks. Please answer ALL the questions simply by placing a cross in the box which you think most nearly applies to you. Remember that we want to know about present and recent complaints, not those you had in the past. It is important that you try to answer ALL the questions.

We would like to know how you have been feeling over the past few weeks.

Please place a cross in the box that most closely describes your experience for each question

a) Have you recently been able to concentrate on whatever you’re doing?

Better than usual □  Same as usual □  Less than usual □  Much less than usual □

b) Have you recently lost much sleep over worry?

Not at all □  No more than usual □  Rather more than usual □  Much more than usual □

c) Have you recently felt that you are playing a useful part in things?

More so than usual □  Same as usual □  Less useful than usual □  Much less useful □

d) Have you recently felt capable of making decisions about things?

More so than usual □  Same as usual □  Less so than usual □  Much less capable □

e) Have you recently felt constantly under strain?

Not at all □  No more than usual □  Rather more than usual □  Much more than usual □

f) Have you recently felt you couldn’t overcome your difficulties?

Not at all □  No more than usual □  Rather more than usual □  Much more than usual □
Appendix B

YOUR HEALTH MORE GENERALLY

g) Have you recently been able to enjoy your normal day-to-day activities?

- More so than usual
- Same as usual
- Less so than usual
- Much less than usual

h) Have you recently been able to face up to your problems?

- More so than usual
- Same as usual
- Less able than usual
- Much less able

i) Have you recently been feeling unhappy and depressed?

- Not at all
- No more than usual
- Rather more than usual
- Much more than usual

j) Have you recently been losing confidence in yourself?

- Not at all
- No more than usual
- Rather more than usual
- Much more than usual

k) Have you recently been thinking of yourself as a worthless person?

- Not at all
- No more than usual
- Rather more than usual
- Much more than usual

l) Have you recently been feeling reasonable happy, all things considered?

- More so than usual
- About same as usual
- Less so than usual
- Much less than usual
Appendix B

SECTION FIVE: PAIN

We are interested in learning more about your pain intensity and disability. For the following questions with a scale of 0-10 please place a cross in ONE box only. Please complete these questions regardless of whether you have pain.

52 a) How would you rate your pain on a 0-10 scale at the present time, that is right now, where 0 is ‘no pain’ and 10 is ‘pain as bad as could be’?

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

b) In the past 6 months, how intense was your worst pain rated on a 0-10 scale where 0 is ‘no pain’ and 10 is ‘pain as bad as could be’?

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

c) In the past 6 months, on the average, how intense was your pain rated on a 0-10 scale where 0 is ‘no pain’ and 10 is ‘pain as bad as could be’? (That is, your usual pain at times you were experiencing pain.)

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

53 a) About how many days in the last 6 months have you been kept from your usual activities (work, school or housework) because of pain? [ ] days

b) In the past 6 months, how much has pain interfered with your daily activities rated on a 0-10 scale where 0 is ‘no interference’ and 10 is ‘unable to carry on any activities’

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

c) In the past 6 months, how much has pain changed your ability to take part in recreational, social and family activities where 0 is ‘no change’ and 10 is ‘extreme change’?

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

d) In the past 6 months, how much pain changed your ability to work (including housework) where 0 is ‘no change’ and 10 is ‘extreme change’?

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

Appendix B

54. Everyone experiences painful situations at some point in their lives. Such experiences may include headaches, tooth pain, joint or muscle pain. People are often exposed to situations that may cause pain such as illness, injury, dental procedures or surgery.

**Instructions:**

*We are interested in the types of thoughts and feelings that you have when you are in pain. Listed below are thirteen statements describing different thoughts and feelings that may be associated with pain. Using the following scale, please indicate the degree to which you have these thoughts and feelings when you are experiencing pain.*

**When I’m in pain …**

<table>
<thead>
<tr>
<th></th>
<th>Not at all</th>
<th>To a slight degree</th>
<th>To a moderate degree</th>
<th>To a great degree</th>
<th>All the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) I worry all the time about whether the pain will end.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>b) I feel I can’t go on.</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>c) It’s terrible and I think it’s never going to get any better.</td>
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<tr>
<td>d) It’s awful and I feel that it overwhelms me.</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>e) I feel I can’t stand it anymore.</td>
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<td></td>
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<tr>
<td>f) I become afraid that the pain will get worse.</td>
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<tr>
<td>g) I keep thinking of other painful events.</td>
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<tr>
<td>h) I anxiously want the pain to go away.</td>
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<tr>
<td>i) I can’t seem to keep it out of my mind.</td>
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<tr>
<td>j) I keep thinking about how much it hurts.</td>
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<td></td>
<td></td>
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<tr>
<td>k) I keep thinking about how badly I want the pain to stop.</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>l) There’s nothing I can do to reduce the intensity of the pain.</td>
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<td></td>
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<tr>
<td>m) I wonder whether something serious may happen.</td>
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</tbody>
</table>
Appendix B

55. We are trying to find out what people think about back trouble. Please indicate your general views towards back trouble, even if you have never had any.

Please indicate whether you agree or disagree with each statement on a scale of 1 to 5, where 1 is completely disagree and 5 is completely agree, by marking a cross in one box on each line.

<table>
<thead>
<tr>
<th>Completely disagree</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Completely agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) There is no real treatment for back trouble</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>b) Back trouble will eventually stop you from working</td>
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<tr>
<td>c) Back trouble means periods of pain for the rest of one’s life</td>
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<tr>
<td>d) Doctors cannot do anything for back trouble</td>
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<tr>
<td>e) A bad back should be exercised</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f) Back trouble makes everything in life worse</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>g) Surgery is the most effective way to treat back trouble</td>
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<td></td>
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<tr>
<td>h) Back trouble may mean you end up in a wheelchair</td>
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<tr>
<td>i) Alternative treatments are the answer to back trouble</td>
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<tr>
<td>j) Back trouble means long periods of time off work</td>
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<tr>
<td>k) Medication is the only way of relieving back trouble</td>
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<tr>
<td>l) Once you’ve had back trouble there is always a weakness</td>
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<tr>
<td>m) Back trouble must be rested</td>
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<tr>
<td>n) Later in life back trouble gets progressively worse</td>
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</tbody>
</table>
SECTION SIX: ABILITY TO WORK

We would like to ask you some questions about your ability to work.

56. Assume that your work ability at its best has a value of 10 points. How many points would you give your current work ability? (0 means that you cannot currently work at all)

<table>
<thead>
<tr>
<th>Completely unable to work</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Your work ability at its best</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very good</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Rather good</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
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<tr>
<td>Rather poor</td>
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<td></td>
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<td></td>
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<tr>
<td>Very poor</td>
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</tbody>
</table>

57. How do you rate your current work ability with respect to the physical demands of your work?

<table>
<thead>
<tr>
<th>Very good</th>
<th>Rather good</th>
<th>Moderate</th>
<th>Rather poor</th>
<th>Very poor</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>

58. How do you rate your current work ability with respect to the mental demands of your work?

<table>
<thead>
<tr>
<th>Very good</th>
<th>Rather good</th>
<th>Moderate</th>
<th>Rather poor</th>
<th>Very poor</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>

59. Considering any illness or injury that you may have, is/are these a hindrance to your current job?

- There is no hindrance / I have no illness or injury
- I am able to do my job, but it causes some symptoms
- I must sometimes slow down my work pace or change my work methods
- I must often slow down my work pace or change my work methods
- Because of my illness or injury, I feel I am able to do only part-time work
- In my opinion, I am entirely unable to work

60. How many whole days have you been off work because of a health problem (illness or injury or health care or for examination) during the past year (12 months)?

<table>
<thead>
<tr>
<th>None at all</th>
<th>1-9 days</th>
<th>10-24 days</th>
<th>25-99 days</th>
<th>100-365 days</th>
</tr>
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<tbody>
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</table>

61. Do you believe that – from the standpoint of your health – you will be able to do your current job two years from now?

<table>
<thead>
<tr>
<th>Unlikely</th>
<th>Uncertain</th>
<th>Relatively certain</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</table>

62. Have you recently been able to enjoy your regular activities?

<table>
<thead>
<tr>
<th>Often</th>
<th>Rather often</th>
<th>Sometimes</th>
<th>Rather seldom</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

63. Have you recently been active and alert?

<table>
<thead>
<tr>
<th>Often</th>
<th>Rather often</th>
<th>Sometimes</th>
<th>Rather seldom</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</tbody>
</table>

64. Have you recently felt yourself to be full of hope for the future?

<table>
<thead>
<tr>
<th>Often</th>
<th>Rather often</th>
<th>Sometimes</th>
<th>Rather seldom</th>
<th>Never</th>
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</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>
On the next page please update your contact details as we would like to contact you regarding any future developments with this study.
## CONTACT DETAILS

Please update your contact details as we would like to contact you for any future developments from the current study.

**Address, street number and street or PO Box:**

**Suburb/Town:**

**State:**

**Post code:**

**Phone: home**

**Phone: mobile**

**Email address:**

## ALTERNATIVE CONTACT DETAILS

In case you move and we lose contact with you, please provide the name and contact details of an alternative contact - relative or friend who may be able to tell us where you are. This should be a person who is at long-term address but who is not living with you. We would only use this alternative contact in the event that we could not contact you at the address you provide.

**Surname (in capitals)**

**Other name(s):**

**Address, street number and street or PO Box:**

**Suburb/Town:**

**State:**

**Post code:**

**Phone: home**

**Phone: mobile**

**Email address:**

**Note:** to ensure confidentiality of your information, this page will be removed by the Monash University Study team and stored separately from the rest of the questionnaire.
We appreciate that your time is valuable and thank you very much for your contribution to this important study.

Please return this questionnaire in the prepaid envelope provided