Kari-Pekka Martimo

Musculoskeletal disorders, disability and work

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MUSCULOSKELETAL DISORDERS, DISABILITY AND WORK

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DOCTORAL DISSERTATION

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ABSTRACT

Musculoskeletal disorders (MSD) are the most important cause of temporary work disability in Finland, and together with mental disorders, they account for the majority of permanent disability pensions. The most common musculoskeletal problem in the working population is low back pain (LBP), which together with some upper extremity disorders (UED) has the strongest scientific evidence of all MSD, that working conditions have a role in the aetiology.

This thesis consists of five studies representing three possible approaches to reducing disability due to MSD at work; prevention of the disorders by reducing their work-related risk factors (primary prevention), prevention of disability as a consequence of the existing MSD (secondary prevention), and prevention of the exacerbation of disability (secondary and tertiary prevention). The studies examine work activity as a risk factor, but also as an indicator of the level of disability and as an opportunity for rehabilitation.

The methods used in primary prevention to change working routines are not supported by evidence gathered in a systematic review showing that widely adapted training in lifting techniques does not help to prevent LBP. Earlier studies in general have shown only modest effects of work-related interventions in the primary prevention of MSD. In terms of secondary prevention, the cross-sectional survey revealed that many workers with MSD consider themselves as partially able to work instead of either totally able or unable. They also frequently perceive their musculoskeletal health problems as being related to work, and the belief was shown to correlate with self-assessed disability. Many workers, however, consider that there are possible changes that could be initiated in the workplace to give them support in working despite their MSD.

According to another survey, medically verified UED cause significant productivity loss at work, even when the employees do not need sick leave because of the symptoms. This lost productivity is usually not included in economic evaluations of the consequences of MSD at work. In the assessment of employees with MSD, productivity loss should be taken into consideration in addition to collecting data on self-assessed work-relatedness of the disorder. If the disorder cannot be medically cured, then the challenge for all parties, i.e. the employee, employer and health service provider, is to accommodate work in order to avoid deterioration of the symptoms due to work, and, on the other hand, impairment of work output because of the symptoms.

Early ergonomic intervention together with adequate medical care restored decreased on-the-job productivity associated with UED better than medical care alone. This randomised controlled trial adds to the relatively scarce body of work on the effectiveness of ergonomic interventions. The results also encourage occupational health personnel to try for an early interaction with the supervisor and to an ergonomic worksite visit if UED is the main complaint of the employee. Compared to regular health care practices, the study intervention was initiated at an earlier stage. Most often in the acute phase of MSD, a purely biomedical model of disability is applied. Only when the disability becomes prolonged, are more work-oriented actions taken. According to the present results, however, ergonomic intervention is less effective when applied at a more severe stage of UED.

Based on the finding that partial work ability is common among employees with MSD, the beneficial effects of modified work on return to work in earlier studies, and the positive attitudes to part-time sick leave reported in other Nordic countries, a randomised controlled trial was designed and initiated to compare part-time sick leave and conventional sickness absence in the management of MSD. During part-time sick leave, the employee is advised and supported to continue working so that the recovery process is not endangered, and both working time and work tasks are modified in collaboration with the supervisor. The results of this trial can be expected in 2011.

This thesis shows that disability caused by MSD can be managed effectively, especially in the occupational health services. Despite the evidence that lifting advice has no effectiveness in primary prevention, the second study did detect encouraging results at the level of secondary prevention. This approach challenges the management of workers with MSD utilising only the biomedical model. The results encourage the adaptation of a biopsychosocial model, where the main focus is shifted from possible anatomic causes towards more complex systems of work disability. In this model, the importance of stakeholder interactions (for example, family, supervisor, co-workers, employer, and insurance company) is stressed together with the crucial role of the individual.

The majority of barriers and facilitators of staying at work despite MSD are related more to psychosocial, workplace and management issues rather than to the physical disorder itself. Therefore, the disease diagnosis perspective in the management of MSD has to be supplemented by a disability diagnosis, by investigating its causal psychosocial and environmental factors. The approach supports effective disability management strategies, which prevent unnecessary sickness absenteeism and allow employees to remain productive at work despite MSD.

YHTEENVETO

Ohimenevää työkyvyttömyyttä aiheuttavat Suomessa eniten tuki- ja liikuntaelinsairaudet. Yhdessä mielenterveyshäiriöiden kanssa ne ovat yleisin syy pysyviin työkyvyttömyyseläkkeisiin. Tavallisin liikuntaelinvaiva työikäisillä on alaselkäkipu. Kaikista liikuntaelinvaivoista selkäkivun ja joidenkin yläraajasairauksien suhteen on eniten näyttöä, että työllä ja työolosuhteilla on merkitystä näiden vaivojen synnyssä.

Tämä väitöskirja koostuu viidestä osatutkimuksesta, jotka edustavat kolmea mahdollisuutta vähentää liikuntaelinsairauksista aiheutuvaa työkyvyn laskua; ennaltaehkäisemällä vaivoja vähentämällä niiden työperäisiä riskitekijöitä (primaaripreventio), vähentämällä olemassa olevista vaivoista aiheutuvaa työkyvyn laskua (sekundaaripreventio) sekä estämällä työkyvyn laskun paheneminen (sekundaari- ja tertiaaripreventio). Väitöskirja käsittelee työtoimintaa riskitekijänä, mutta myös työkyvyn mittarina ja kuntoutumismahdollisuutena.

Primaaripreventiossa käytetyt työskentelytapoihin kohdistuneet menetelmät tulevat kyseenalaistetuiksi tässä tutkimuksessa. Järjestelmällisessä kirjallisuuskatsauksessa osoitetaan, että laajalti käytössä oleva nostotekniikoiden opettaminen ei autakaan ehkäisemään alaselkäkipua taakankäsittelyssä. Aikaisemmatkin tutkimukset ovat yleensä osoittaneet, että työperäisillä interventioilla on vain vaatimattomia vaikutuksia liikuntaelinvaivojen primaaripreventiossa. Sekundaaripreventiön osalta poikittaistutkimuksessa osoitetaan, että monet työntekijät ovat mielestään liikuntaelinvaivasta huolimatta osittain työkykyisiä sen sijaan, että pitäisivät itseään joko täysin työkykyisinä tai työkyvyttöminä. Heidän mielestään liikuntaelinvaivat ovat usein myös työperäisiä, millä tutkimuksessa osoitetaan olevan yhteyttä itsearvioituun työkyvyn laskuun.

Monien työntekijöiden mielestä työpaikalla on kuitenkin mahdollisuuksia sellaisiin muutoksiin, jotka auttavat heitä selviytymään työssään liikuntaelinvaivasta huolimatta.

Toisen poikkileikkaustutkimuksen mukaan lääkärin toteama yläraajavaiva aiheuttaa merkittävää tuottavuuden alenemaa työssä myös silloin, kun työntekijä ei ole oireiden vuoksi sairausloman tarpeessa. Tätä tuottavuuden alenemaa ei yleensä huomioida, kun arvioidaan liikuntaelinvaivojen aiheuttamia taloudellisia seurauksia työssä. Liikuntaelinoireisen työntekijän tutkimisessa tulisi huomioida sairaudesta aiheutuva tuottavuuden lasku samoin kuin työntekijän oma arvio vaivan työperäisyydestä. Vaikka sairautta ei voi lääketieteellisesti parantaa, työntekijän, työnantajan ja terveydenhuollon yhteinen haaste on mukauttaa työtä niin, että vältetään sekä työstä aiheutuva oireiden paheneminen että oireista johtuva työn tuloksen heikkeneminen.

Yhdistämällä varhaisia ergonomisia toimenpiteitä asianmukaiseen lääketieteellisen hoitoon voidaan palauttaa yläraajavaivoihin liittyvä alentunut työtuottavuus paremmin kuin pelkällä lääketieteellisellä hoidolla. Tämä satunnaistettu kontrolloitu tutkimus tukee tähän mennessä vähäistä näyttöä ergonomisten toimenpiteiden vaikuttavuudesta. Tulokset myös kannustavat työterveyshenkilöstöä olemaan varhaisessa vaiheessa yhteydessä esimieheen ja käymään työpaikalla, mikäli työntekijän pääongelma on yläraajavaiva. Verrattuna terveydenhuollon tavanomaiseen toimintaan tutkimuksen toimenpiteet aloitettiin varhaisemmassa vaiheessa. Useimmiten liikuntaelinvaivan akuutin vaiheen hoidossa sovelletaan vain puhtaasti lääketieteellistä mallia. Vasta kun työkyvyn lasku pitkittyy, ryhdytään työhön liittyviin toimenpiteisiin. Tulosten mukaan ergonomiset toimenpiteet ovat kuitenkin vähemmän vaikuttavia, jos niihin ryhdytään vasta yläraajavaivan muututtua vakavammaksi.

Osittainen työkyky on yleistä liikuntaelinvaivoista kärsivillä työntekijöillä. Lisäksi aikaisemmin tutkimuksissa on osoitettu, että mukautetulla työllä voidaan nopeuttaa työhön paluuta sairausloman jälkeen. Kun vielä muissa Pohjoismaissa on kuvattu myönteistä suhtautumista osa-aikaiseen sairauspoissaoloon, viides osajulkaisu kuvaa satunnaistetun kontrolloidun tutkimuksen, jossa verrataan osa-aikaista ja perinteistä sairauspoissaoloa liikuntaelinsairauksien hoidossa. "Osasairausvapaan" aikana työntekijää ohjataan ja tuetaan jatkamaan työssään toipumista vaarantamatta, kun sekä työaikaa että työtehtäviä muokataan yhteistyössä esimiehen kanssa. Tämän tutkimuksen tulokset ovat käytettävissä vuonna 2011.

Tämä väitöskirja osoittaa, että liikuntaelinvaivoista aiheutuvaa työkyvyn laskua voidaan hoitaa tehokkaasti erityisesti työterveyshuollossa. Vaikka tutkimusten mukaan nosto-opetus primaaripreventiona ei ole vaikuttavaa, toinen osajulkaisu osoittaa, että sekundaaripreventiossa saadaan kannustavia tuloksia. Tämä haastaa pelkän lääketieteellisen mallin käytön ja kannustaa biopsykososiaalisen mallin hyödyntämiseen liikuntaelinvaivoista kärsivien työntekijöiden hoidossa. Päähuomio siirretään mahdollisista rakenteellisista syistä kohti työkyvyttömyyteen liittyviä monimutkaisempia järjestelmiä, joissa painotetaan sekä sosiaalisia vuorovaikutussuhteita (esim. perhe, esimies, työkaverit, työnantaja ja vakuutusyhtiö) että yksilön keskeistä asemaa.

Suurin osa liikuntaelinvaivan kanssa työssä jatkamisen esteistä ja mahdollistajista liittyy enemmän psykososiaalisiin tekijöihin sekä työhön ja johtamiseen kuin fyysiseen vaivaan sinänsä. Siksi diagnoosin lisäksi liikuntaelinvaivojen hoidossa on tutkittava työkyvyttömyyttä aiheuttavia ja ylläpitäviä psykososiaalisia ja ympäristöön liittyviä tekijöitä. Tämä lähestymistapa luo mahdollisuuksia tukea työkykyä, välttää tarpeeton sairauspoissaolo ja edesauttaa työntekijöiden työssä jatkamista tuottavasti liikuntaelinvaivasta huolimatta.

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Helsinki, May 3, 2010

Kari-Pekka Martimo

ABBREVIATIONS

CCT	controlled clinical trial (nonrandomised)
CI	confidence interval
CTS	carpal tunnel syndrome
FIOH	Finnish Institute of Occupational Health
GEE	generalized estimating equation
ICF	International Classification of Disability, Functioning and Health
LBP	low back pain
MSD	musculoskeletal disorders
OH(S)	occupational health (services)
OR	odds ratio
QQ	Quantity and Quality method
RTW	return to work
RCT	randomised controlled trial
UED	upper extremity disorders
WHO	World Health Organisation

LIST OF ORIGINAL PUBLICATIONS

I Martimo KP, Verbeek J, Karppinen J, Furlan AD, Takala EP, Kuijer PPFM, Jauhiainen M, Viikari-Juntura E (2008). Effect of training and lifting equipment for preventing back pain in lifting and handling: systematic review. BMJ 336(7641):429–31

II Martimo KP, Varonen H, Husman K, Viikari-Juntura E (2007). Factors associated with self-assessed work ability. Occup Med (Lond) 57(5):380–2.

III Martimo KP, Shiri R, Miranda H, Ketola R, Varonen H, Viikari-Juntura E (2009). Self-reported productivity loss among workers with upper extremity disorders. Scand J Work Environ Health 35(4):301–8.

IV Martimo KP, Shiri R, Miranda H, Ketola R, Varonen H, Viikari-Juntura E (2010). Effectiveness of an ergonomic intervention on productivity of workers with upper extremity disorders: – a randomised controlled trial. Scand J Work Environ Health 36(1):25–33.

V Martimo KP, Kaila-Kangas L, Kausto J, Takala EP, Ketola R, Riihimaki H, Luukkonen R, Karppinen J, Miranda H, Viikari-Juntura E (2008). Effectiveness of early part-time sick leave in musculoskeletal disorders (Study protocol). BMC Musculoskeletal Disorders 9:23 doi:10.1186/1471-2474-9-23

CONTENTS

1. INTRODUCTION

One of the most crucial aspects of life is health. This does not mean only the absence of symptoms, illness and morbidity (WHO 2001). Health also maintains capacity to attain one's own goals through target-oriented actions, i.e., paid or unpaid work. The World Health Organisation (WHO) has classified health and functioning using three different domains: body functions and structures, activity (level of capacity; what a person can do in a standard environment), and participation (level of performance; what a person can do in their usual environment) (WHO 2001). In the International Classification of Functioning, Disability and Health (ICF), the term "functioning" is used to refer to all body functions, activities and participation. Similarly, the term "disability" refers to all impairments, activity limitations and participation restrictions.

Disability is explained as "something that restricts or limits". Therefore, the Finnish translation "työkyvyttömyys" (work incapacity) for the term "work disability" can be considered as misleading. It reinforces the false understanding that work disability is a dichotomous factor, i.e. you have either full capacity ("työkykyinen") or you are entirely incapacitated ("työkyvytön"). This is not supported by ICF, which views disability and functioning as interactions between health conditions (diseases, disorders and injuries) and contextual factors (external environmental and internal personal factors) (figure 1). Disability involves dysfunctioning at one or more of the three domains (impairments, activity limitations, and restricted participation). Restrictions and barriers to performance of functional activities or roles in which a person engages in the context of his or her life are also considered to have an influence upon health outcomes and the health recovery process. ICF has utilized a biopsychosocial model of disability (explained in more details in chapter 2.2.2.).

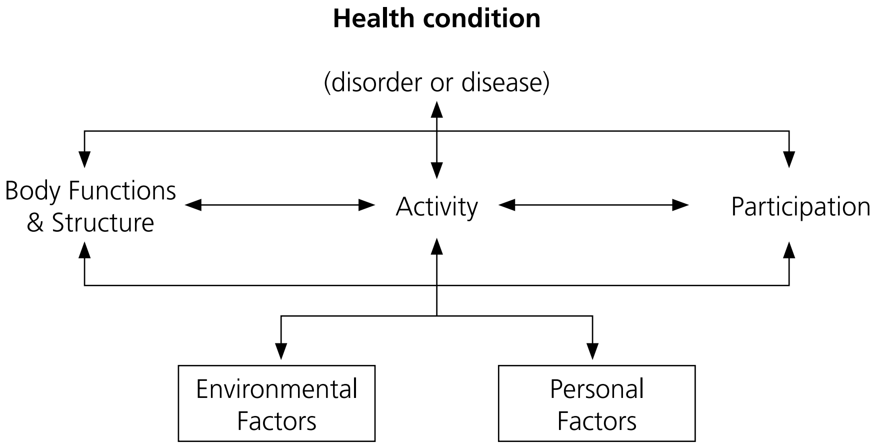

FIGURE 1. Interactions between the components of ICF (WHO 2001)

According to ICF, the disability process initiated by a health condition is influenced by both environmental and personal factors. Environmental factors can include social attitudes, architectural characteristics, legal and social structure, as well as climate and terrain. The personal factors are gender, age, coping styles, social background, education, profession, past and current experience of health conditions, overall behaviour pattern, personality, and other factors that influence the perception of disability by the individual.

Disability does not mean total loss of functioning in any of the three domains. Despite of a medical condition (for example, seropositivity for Human Immunodeficiency virus), a person may be fully functional in both the activity and participation domains. In addition, and particularly with participation, restrictions (problems an individual may experience in involvement in life situations) can be considered as problems created by an unaccommodating physical environment as a result of attitudes and other features of the social environment.

Lately the positive effects of work have gained increasing attention (Waddell et al. 2006). Work often plays a role in promoting both physical and mental health: physical activity (for example, work) is usually associated with improvement in physical capacity, while goal achievement, social interactions, and self-realisation in work are sources of satisfaction and enhanced self-esteem (WHO 1985). Therefore, instead of leaving work life, people with disabilities should be encouraged to continue in employment, provided that work is adapted to human goals, capacities and limitations, and occupational hazards are under control.

2. REVIEW OF CONCEPTS

2.1. Musculoskeletal disorders

2.1.1. General

The musculoskeletal system comprises of bones and joints with their adjacent structures, as well as muscles, tendons and ligaments. This study is concerned with disability caused by or associated with musculoskeletal disorders (MSD). In Finland, MSD are the most important causes of temporary disability (lasting less than one year) (Kansaneläkelaitos 2008). MSD along with respiratory infections are the most common reasons for the use of primary health services. In addition, MSD and mental disorders account for the majority of permanent disability pensions in Finland.

”Disorder” in this study refers to any complaint, symptom or disease of the musculoskeletal system. Complaint is an explicit health problem experienced by an individual. Disease, on the other hand, is a clinically verifiable entity that is detected in a clinical examination. Standardized clinical examination protocols for many common musculoskeletal symptoms are available in order to achieve a more reliable and comparable diagnosis (Sluiter et al. 2001).

Low back pain (LBP) and upper extremity disorders (UED) are scrutinized in this thesis, since LBP is the most common musculoskeletal cause of disability and there is strong evidence of work-relatedness for both UED and LBP (Punnett et al. 2004).

2.1.2. Low back pain

LBP is defined as pain in the lumbar and/or gluteal region with or without radiation to the lower extremities. It is often categorised according to the duration of the symptoms: acute pain with less than 4–6 weeks, sub-acute between 4–6 and 8–12 weeks and chronic as pain of more than 8–12 weeks of duration. However, "long-lasting" or "prolonged" should be preferred instead of "chronic" in order to avoid unnecessary labelling of the employee with LBP being "chronically" ill.

Various diagnoses and pathological conditions may manifest with LBP. However, the overwhelming majority of back pain cases remain nonspecific. About 85 % of patients with isolated LBP in primary care cannot be given any precise pathoanatomical diagnosis, and the association between symptoms and imaging results is weak (Deyo et al. 2001). In about 3 % of cases the reasons for LBP are neoplasia, infection, visceral pain or systemic disease.

Despite the fact that back pain is not a life threatening condition, it constitutes a major public health problem in the Western industrialised societies. LBP affects a large number of people each year and is the cause of severe discomfort and financial losses (Maniadakis et al. 2000). One important feature of workers with nonspecific back pain is that a small proportion of cases (<10 %) accounts for most of the costs (>70 %) (Dionne et al. 2005). Due to its high prevalence, back pain is a leading reason for physician visits, hospitalisations and other health and social care service utilisation.

The severity and type of back pain change with age even though LBP is common already in adolescence and early adulthood (Mikkelsson et al. 1997). It becomes more severe around the age of 40, showing different development of nonspecific and radiating LBP. According to a longitudinal study of a representative population, moderate as well as major nonspecific LBP declines with age, whereas the incidence of major radiating LBP increases with age (Shiri et al. 2010).

2.1.3. Upper extremity disorders

Soft tissue MSD of the upper limb and shoulder region comprise a heterogeneous group of conditions ranging from specific upper limb conditions, like de Quervain's tenosynovitis, epicondylitis, rotator cuff tendinitis, and carpal tunnel syndrome (CTS), to non-specific regional pain syndromes. Labels such as "repetitive strain injury", "cumulative trauma disorder" and "work-related upper limb pain" have been often used (Walker-Bone et al. 2005), but should be applied with caution, because they already include an assumption of the aetiology of the disorder. In addition, "non-specific forearm pain" has been adopted as the diagnostic label for patients presenting with forearm pain without physical signs (Walker-Bone et al. 2005; van Tulder M 2007). Some agreed systems of classification of UED have been developed to improve the quality of epidemiological research (Harrington et al. 1998; Sluiter et al. 2001; Helliwell et al. 2003).

UED are common in the work force. In a population-based study of Finnish adults, the prevalence of a clinically diagnosed UED was highest for rotator cuff tendinitis and CTS (both 3.8 %), followed by lateral epicondylitis (1.1 %), bicipital tendinitis (0.5 %), and medial epicondylitis (0.3 %) (Shiri et al. 2007). In Finland, 1070 work-related MSD were reported to the register of work-related diseases in 2007 representing 17 % of all confirmed or suspected occupational diseases (Karjalainen et al. 2009). The most common diagnoses were related to the upper extremities; epicondylitis (half of all cases), tenosynovitis, and CTS.

2.1.4. Work-related musculoskeletal disorders

MSD are multifactorial in their origin, and when affecting workers, they can be work-related in a number of ways: MSD may be partially caused by adverse work conditions; they may be aggravated, accelerated or exacerbated by workplace exposures; and they may impair work capacity. It is also important to remember that personal characteristics (including genetic factors), as well as environmental and sociocultural factors usually play a role as risk factors for work-related diseases (WHO 1985). In addition, due to the high prevalence and recurrence rates of MSD (especially LBP), caution has been advised in relating these disorders exclusively to the workplace (Werner et al. 2009).

According to the Finnish Work and Health Survey conducted in 2006 (Kauppinen et al. 2007), 28 % of the 2229 interviewed employees reported long-term or recurrent physical or psychological symptoms that had been caused or worsened by work during the last month. Depending on the location of the symptoms, 63–91 % of those with musculoskeletal symptoms considered them to be related to work.

A systematic review showed that potentially work-related diseases are common in general practice (Weevers et al. 2005). High prevalence rates of potentially work-related diseases were found for LBP, neck pain and shoulder pain. According to the results of a Norwegian survey, the majority of cases with MSD were assessed as being work-related by both the study participants and the experts: 80 % versus 65 % for pain in the neck or shoulder region and 78 % versus 72 % for arm pain (Mehlum et al. 2009).

It has been argued in the Netherlands that too little attention is paid to the possible work-relatedness of health complaints, and that this can be a major cause of sickness absence and disability (Buijs et al. 2005). If the physicians cannot relate the patients' health complaints to work factors, they are at risk of making an inadequate assessment or they may miss effective therapeutic measures. This can lead to unnecessary long sickness absence periods, and, even possibly, permanent disability.

2.2. Disability

Disability is studied in this thesis from the perspective of problems in the participation at work, "occupational/work disability". The term "disability", however, will be used for simplicity. The special focus is on the relation of disability and work, how work affects the employee's health and functioning at work, and how a medical condition can impact on the employee's ability to continue working, paying special attention to contextual, personal and environmental factors.

Occupational or work disability is usually defined as time off work, reduced productivity, or working with functional limitations as a result (outcome) of either traumatic or non-traumatic clinical conditions (Schultz et al. 2007b).

There does not exist one single model of diagnosis and rehabilitation of pain-related occupational disability, but many, often competing and conflicting, models currently exist. The core issue is to select the right model for the right service recipient at the right time.

In the context of work disability, observational studies have demonstrated that adverse disability outcomes are inextricably linked with communication failures between the employee and the care provider, and description of successful programmes often cite effective or improved communication as an important element in their success (Pransky et al. 2004). Therefore, effective communication can be seen as a prerequisite for success, regardless of the specific approach to disability management and prevention.

2.2.1. Biomedical model

The *biomedical model* (also called as the "disease paradigm") is the predominant framework used by a large group of health care professionals as most health care systems are still based on a purely medical model of illness and injury. In this model, illness is considered to be a consequence of the ill-functioning of the human organism as a "biological machine", and the disease is described as a linear sequence from cause factor to pathology, to symptoms or manifestations (Schultz et al. 2000). The second tenet of the biomechanical model holds that symptoms and disability are directly related to, and proportionate to, the severity of biological pathology. Therefore according to this theory, elimination of pathological causes will inevitably result in cure or improvement. Intervention studies employing this approach have focused on the role of specific medical treatments or clinical approaches intended to prevent prolonged disability (Pransky et al. 2004).

Communication in the biomedical model is often unidirectional (physician to employer and patient), not interactive, as physicians issue definitive pronouncements about cause, diagnosis and function. In addition, patients usually adhere to the biomedical model diffused in the media, meaning that their expectations may be inconsistent with other models that would best suit their condition (Loisel et al. 2005).

Considering the complex nature of pain, solely focussing on biomedical pathology results in a lack of consideration of the multidimensional nature of the phenomenon, the variety of reactions to pain, and the changing nature of injury and pain over time (Schultz et al. 2000). This exclusive attention on objectively identified pathology negates the importance of patient-centred measures of pain, symptoms and disability. "Objective" measures of pathology, however, have been shown to predict disability rather poorly, and a pathophysiological explanation cannot be offered in all MSD. The search for what is usually an elusive "medical explanation" of pain in most cases prolongs the diagnostic process needlessly. As a result, this model, when applied to nonspecific pain conditions, can increase chronicity and human suffering and impose a financial burden on health care and compensation systems.

For those kinds of injuries and illnesses where healing processes are highly predictable and the risk of re-injury is low (minor lacerations, trauma, or fractures), the biomedical model performs well (Pransky et al. 2004). This model is relevant with respect to medical decision making, particularly with regard to uncomplicated, physical injuries or pain or both in its acute stages, as well as in the identification of medical "red flags", i.e., ruling out of serious medical conditions, such as tumours, infections and fractures (Schultz et al. 2000).

2.2.2. Biopsychosocial model

From an epidemiological perspective, it appears that non-clinical factors are more likely than clinical at explaining long-term disability cases (Loisel 2009). Therefore, it is not a question of improving clinical care in order to achieve better treatment results. The *biopsychosocial approach* has been modified in many different forms and is generally the most commonly considered and consensual framework for understanding the multidimensional aspects of many health problems (Schultz et al. 2007b). The biopsychosocial model recognizes that the relationships between pain, physical and psychological impairment, functional and social disability are far from simple; pain and response to MSD are complex and interacting phenomena (Schultz et al. 2000). This approach demands a conceptual shift from the linear way of thinking of the biomedical model to an open system perspective.

Research on this topic has yielded substantial evidence on the determinants of work disability. These determinants can be linked to the worker (personal), workplace design or organisation (workplace-related), healthcare system, compensation system or the nature of the local culture and society (Loisel 2009). The paradigm shift from a biomedical to a biopsychosocial model of disability transfers responsibility for outcomes from the healthcare provider-patient relationship to a multi-player decision-making system which is influenced by complex professional, legal, administrative, and cultural (societal) interactions (Loisel et al. 2005).

Based on the principles of the biopsychosocial model, in the *case management model,* the client is an active participant in the rehabilitation process, and the rehabilitation team only facilitates this process (Schultz et al. 2000). The therapeutic focus is the restoration of full function, not symptom removal or "cure", and the restoration of employment status with minimal delay is one of the major goals of treatment (Schultz et al. 2000). Early intervention designed to restore physical or role function, increase activity levels, and to achieve work maintenance or work re-entry is considered to expedite the return to work (RTW) process.

Case management is essential when the client's treatment has to be coordinated, planned and monitored. This emphasis stems from the belief that the longer the pain and disability persist, the more difficult they will be to treat. Therefore identification of those factors that predict poor prognosis for continued disability and identification of those workers at high risk for continued work disability are important components of early intervention (Schultz et al. 2000).

2.2.3. Other models

The major tenet of the *insurance model* (also called as forensic, compensation or the "perverse incentives" model) is that claimants who anticipate financial benefits through compensation, pending litigation, special services or considerations, such as job transfer or reduced workload, are likely to be dishonest about their symptoms (Schultz et al. 2000). There is a strong moralistic element in this model where it is necessary to clearly differentiate between "honest" and "dishonest" claimants. The insurance model nurtures a climate wherein the claimant must vigorously prove and prove again his or her disability with objective, verifiable, repeatable medical evidence of impairment.

Another subgroup of the medical model is the *psychiatric model* with the basic tenet that pain is either organic or psychological in its origin (Schultz et al. 2000). Pain that cannot be attributed to physical causes must be psychological, and patients with undiagnosed, intractable pain are a psychologically homogenous group. The diagnosis of a mental disorder can entitle a patient to receive services and benefits that might not otherwise have been available. However, the psychiatric framework for pain has proven to be ineffective for rehabilitation and can be diagnostically misguiding (Schultz et al. 2000).

The *physical rehabilitation model* can also be related to the biomedical model, because its focus in disability management and prevention strategies is on improved physical conditioning (Pransky et al. 2004). This model assumes that RTW outcomes can be improved by muscle-strengthening exercises in a clinical or workplace setting that simulates actual working conditions. One limitation of this model, however, is that work environments may be difficult to simulate especially when, in real life, psychosocial and organisational factors are significant contributors to disability (Pransky et al. 2004). In addition, the traditional rehabilitation model seems one-sided: disability management simply focuses on improving worker capabilities to match job demands without any thought of redesigning or modifying jobs to match worker limitations.

A *job-match model* for disability management uses an analytical strategy to assess the match between an individual with functional limitations and a particular job (Pransky et al. 2004). This model may prove useful for workplace accommodation efforts where biomechanical requirements are uniform, and ergonomic risks are relatively easy to define (for example, assembly-line workers, keyboard operators). This approach assumes that the worker capabilities are easily quantified in relation to job tasks, all physical demands are captured by physical measures, and that demands are static over time. These assumptions are rarely realistic in the modern work environment. In addition, the job-match model does not address psychosocial factors or how an employee-job mismatch is translated into the appropriate accommodation (Pransky et al. 2004).

2.3. Disability and work

The process of falling ill, being absent from work, recovering and then returning to work has been represented schematically (European Foundation for the Improvement of Living and Working Conditions 1997). The onset of disability is viewed in terms of an imbalance between the person and the environment (figure 2). Depending on the opportunity and need for absenteeism ("absenteeism barrier"), health problems may result in absenteeism and incapacity to work. RTW depends on the

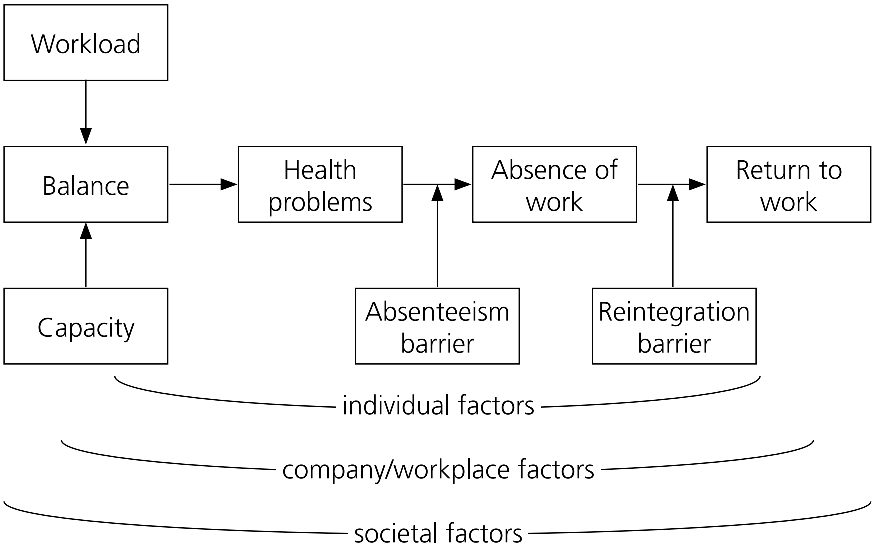

FIGURE 2. The process of becoming ill, being absent from work, recovering and return to work (European Foundation for the Improvement of Living and Working Conditions 1997)

course of the illness and the "reintegration barrier", which refers to the totality of factors which affect the course of the illness and RTW. This whole process is influenced by individual factors, company and workplace factors, as well as factors pertaining to the surrounding society.

The definitions of duration of occupational disability range from cumulative, as in the duration of all days lost from work starting with the date of the onset of symptoms, through categorical, for example RTW status (yes/no), to continuous, such as time to RTW. In addition, predictors of disability and predictors of RTW often differ (Schultz et al. 2007b).

2.3.1. Sickness absenteeism

When a medical condition is severe enough it impedes job performance to the degree that the employee is not able to continue working because of excessively low functional capacity in relation to the explicit or implied job demands. Other reasons for absence from work are that the exposure at work makes the symptoms worse or medical care and rehabilitation requires that the employee cannot be present at work. When the employee abstains from working because of a disabling medical condition, this is called sickness absence (or sick leave), and the phenomenon sickness absenteeism.

Sickness absence is measured by asking the employee how much time he or she has missed from work because of ill health. The other and more reliable alternative is to rely on statistics collected by employers on how much time the employees have been absent from work because of illness. If the statistics are not available, self-reported data have been found to be reliable and valid, when the recall periods are short (i.e., 1–2 weeks) (Mattke et al. 2007). Even when the recall period is up to one year, the agreement between the number of self-reported and the number of recorded sickness absence days is relatively good (Ferrie et al. 2005; Voss et al. 2008). If the recall periods are longer, the results need to be viewed with caution.

The following basic measures have been suggested for assessing sick leaves: frequency (total number of sick leave periods/all employees), length (sick-leave days/sick-listed persons), incidence (new spells/(number of employees x number of days minus all sick-leave days)), cumulative incidence (number of employees with sick leave periods/all employees), and duration (sick-leave days/sick leave periods) (Hensing et al. 1998). It is also beneficial to separate short and long term absence periods, as only medically certified (long term) absences have been shown to serve as a global measure of health, but not short self certified absences (Kivimäki et al. 2003).

In a large prospective cohort study with Finnish municipal employees, the measures of sickness absence (long term absence periods and sick days) were shown to be strong predictors of all cause mortality and mortality due to cardiovascular disease, cancer, alcohol related causes, and suicide (Vahtera et al. 2004). Medically certified absences due to circulatory diseases, surgical operations, and psychiatric diagnoses (but not MSD) were associated with increased mortality also among British civil servants (Head et al. 2008).

In a survey among Finnish labour union members (Böckerman et al. 2009), absenteeism caused by any reason was positively associated with participation in shift or period work, whereas regular overtime was associated with less sickness absenteeism. The possibility to stay at home up to three days without any certificate was not associated with any increase in sickness absenteeism.

2.3.2. Sickness presenteeism (productivity loss at work)

Health disorders do not cause merely absence from work, but also decreased on-the-job performance while at work, which is called "sickness presenteeism". The shorter term "presenteeism" will be used in this text to describe productivity loss at work due to MSD, even if presenteeism can also be caused by factors other than health (for example, organisational dysfunction or distracting domestic problems). A systematic review covering 37 studies concluded that several health conditions, such as asthma and allergies, as well as health risk factors, like obesity and physical inactivity, are associated with presenteeism (Schultz et al. 2007a).

However, the measurement of productivity and its loss at work is difficult. In some professions, like telephone customer operators, productivity can be measured objectively using key strokes or the number of received telephone calls as the indicator. On the other hand, particularly in information and service-type occupations the output at work is difficult to quantify. Therefore, a multitude of workplace productivity measurement instruments have been created and evaluated (Mattke et al. 2007). Nonetheless, the most common approach of measuring presenteeism is assessment of perceived impairment, accomplished by asking employees how much their illnesses hinder them in performing common mental, physical, and interpersonal activities and in meeting job demands (Mattke et al. 2007).

The consequences of presenteeism have been studied from the organisational as well as from the individual perspective. In the North American literature, the focus has been on health and productivity as a business strategy (Goetzel et al. 2007). This approach is based on the finding that health-related productivity costs are significantly greater than medical or pharmacy costs alone (on average 2.3 to 1), and that chronic conditions such as depression/anxiety, obesity, arthritis, and back/neck pain are especially important causes of productivity loss (Loeppke et al. 2009). Since employers are the ultimate purchasers of health care services for the majority of employees in the United States, these findings have prompted employers to develop and evaluate the cost-effectiveness of health and productivity interventions.

In the European literature, more attention has been paid to the consequences of presenteeism at the individual level, based on the findings that 63–83 % of employees reported having worked despite illness on at least one occasion during the previous year (Bergström et al. 2009). Sickness presenteeism seems to be more sensitive to work time arrangements than sickness absenteeism, even though the direction of causality could not be explored in a cross-sectional study (Böckerman et al. 2009).

According to a Swedish review on sickness absenteeism and presenteeism, no studies were found on the consequences of sickness presenteeism for the individual (SBU 2004). Productivity loss, however, is common both before and after periods of sickness absence (Brouwer et al. 2002). Perhaps therefore presenteeism has been associated with more sickness absenteeism in several studies. A Swedish prospective study (Bergström et al. 2009) concluded that working despite the fact that the employee felt that sick leave should have been taken was a statistically significant risk (relative risk 1.4–1.5) for future sick leave of more than 30 days. In the same study, however, taking sick leave during the baseline year was an even greater risk factor for future sick leave; relative risk was 1.5–5.4 depending on the number of days on sick leave. Therefore, sick leave may not be an alternative to sickness presenteeism, if future sickness absenteeism is to be prevented.

A large prospective cohort study with a 3-year follow-up among British civil servants showed that the incidence of serious coronary events was twice as high among employees who did not take sick leave despite poor perceived health at baseline, compared to those "unhealthy" employees with moderate levels of sickness absenteeism (Kivimäki et al. 2005). This phenomenon has been later studied though it has not been possible to detect any evidence that working while ill would act as a short-term trigger for coronary events (Westerlund et al. 2009). According to the authors, two potential explanations remain. Working while ill might contribute to a cumulative psychological burden with pathophysiologic consequences, or that sickness presenteeism, instead of being a causal agent, is only a marker of a lifestyle in which symptoms are ignored and medical care is not sought (Westerlund et al. 2009).

2.3.3. Return to work

RTW can be conceptualised as the "process" of returning an injured worker to work (for example, graduated RTW or job accommodation) or as the measurable final common outcome of disability: the status of working or not working (Schultz et al. 2007b). RTW as an outcome may involve return to the pre-injury employer or the pre-injury job, with or without accommodation (Schultz et al. 2007b). Consequently, the perspectives on, and measurements of, RTW in research and practice vary widely and depend on the stakeholders involved in the evaluation process.

Instead of focusing on the characteristics of work disability, the main emphasis should be on the actions associated with successful work resumption. Therefore, RTW has been presented as an evolving process comprising of four key phases: off work, work re-entry, retention, and advancement (Young et al. 2005). The end of each RTW phase marks the achievement of important RTW outcomes: the ability to attempt work re-entry, the ability to perform satisfactorily, the ability to maintain employment, and the ability to advance in one's career.

Sickness absenteeism and RTW are dependent on each other; disability can be measured both as prolonged sick leave and delayed RTW. Therefore, it is sometimes difficult to differentiate whether the study has been concerned with sickness absenteeism or RTW. In this thesis, the studies have been categorised according to the main outcome measure; the length of sickness absence or successful RTW. The former studies are labelled as studies on sickness absenteeism, and the latter as studies on RTW.

2.3.4. Work-related interventions

The definition of "work-related intervention" used in this thesis has been adopted from a recent Cochrane review on interventions focusing on changes in the workplace or equipment, work design or organisation (including working relationships), working conditions or working environment, and occupational (case) management with active stakeholder involvement of (at least) the worker and the employer (van Oostrom et al. 2009).

According to Cole et al (Cole et al. 2003), workplace interventions to reduce mechanical exposures can be executed at eight different levels:

1. Business sector (for example, ergonomic best practices)
2. Organisation or company (for example, ergonomic policy, audit)
3. Plant or workplace (for example, ergonomic change teams)
4. Line or department (for example, reorganised flow)
5. Work group (for example, safety climate training, job rotation)
6. Job (for example, job enlargement, regular breaks)
7. Worker (for example, ergonomic training, workstation adjustment)
8. Task or tool (for example, sharpening improvements, new trimming tools, lift assists)

Health care activities aimed at preventing MSD and related disability can be divided into three theoretical categories (National Research Council and Institute of Medicine 2001). *Primary prevention* occurs when the intervention is undertaken before workers at risk have acquired a condition of concern, for example, educational programs to reduce the number of new cases (incidence) of LBP. *Secondary prevention* occurs when the intervention is undertaken after individuals have experienced the condition of concern, for example, introduction of job redesign for workers with symptoms of CTS. Tertiary prevention strategies are designed for individuals with chronically disabling MSD; the goal is to achieve maximal functional capacity within the limitations of that individual's impairments.

Similar three-level approach has been introduced to disability management, in which the main focus is not on the clinical symptoms but on related disability (Loisel 2009): (A) Primary prevention consists of looking at the work-related factors in order to prevent not only symptoms or disorders but also related disability; (B) Secondary prevention includes paying attention to the workers with symptoms or disorders, and instigating actions to help these workers recover or improve their working situation instead of sick leave or lower productivity at work due to health problems; (C) Tertiary disability prevention is conceptualised by interventions that prevent unnecessary prolongation of sickness absenteeism and support safe RTW.

Organisational experiments to improve occupational health are usually regarded as laboratory-based experiments in the natural sciences, even if in organisations the conditions are totally different. The prerequisites of temporal priority, control over important variables, and random allocation of subjects to treatment or control groups are usually hard to fulfil (Griffiths 1999). In their comprehensive review on interventions to reduce work-related MSD (Silverstein et al. 2004), Silverstein and Clarke reported that it was extremely difficult to randomise engineering controls in multiple workplaces, and much easier to randomise personal behaviour (exercise, education, medical treatment). Many studies have been confronted with changes in workplaces that are unplanned by the researchers and beyond their control. Stable workplaces with large numbers of workers performing the same work are largely a thing of the past.

Quite evidently the available research on disability is methodologically different from the epidemiological studies on occupational risks of MSD. The latter are scientifically more rigorous in confirming cause-and-effect relationships and allowing prediction. Studies on disability, however, include less tangible factors, such as the design, management, and organisation of work, where it is unrealistic to expect that there would be a natural scientific paradigm to explain these highly complex, constantly changing systems and to predict the specific effects on individual behaviour and health (Griffiths 1999). This has led to the fact that studies on disability have applied not only quantitative but also more qualitative methodologies.

3. PREVIOUS STUDIES ON MUSCULOSKELETAL DISORDERS, DISABILITY AND WORK

The following review is descriptive and primarily based on the results of recently published reviews gathered from the main occupational health (OH) journals. In addition, selected individual studies have been included if they have been published recently, or they are considered especially interesting in the context of this thesis.

3.1. Work-related risk factors of musculoskeletal disorders

3.1.1. Background

A thorough comprehension of the causal association between occupational exposures and MSD is necessary if one wishes to establish occupational guidelines for the primary prevention of MSD, to identify potential work modifications for the secondary prevention, and to provide guidance for the stakeholders involved in the process of long-term disability. This, however, is not a simple task to accomplish.

Epidemiological research relies upon the use of diagnostic criteria capable of separating states of disease with different causes, prognosis, or response to treatment (Walker-Bone et al. 2005). In most studies on back pain, the operationalisation based on the symptom reporting does not allow examination of the risk factors for different groups of back pain, classified based on characteristics such as the duration, frequency, intensity, and localisation of the pain (Hoogendoorn et al. 1999). Lately a Delphi consensus process was used in order to reach a substantial agreement on LBP outcomes that would be combinable into a meta-analysis (Griffith et al. 2007).

Many studies in the field of MSD are cross-sectional surveys relying on self-reported symptoms as the indicators of MSD. This approach has two major aspects which need to be taken into consideration. First, the weakness in cross-sectional studies is the difficulty to distinguish cause and effect, as well as risk factors that prolong (and not cause) the disorder. Second, the determinants of specific MSD seem to differ from those of subjective complaints without clinical findings (Miranda et al. 2005). Such complaints may be indicators of adverse psychological and psychosocial factors rather than the presence of an underlying pathologic condition.

Information on exposures in the studies is often self-reported and not supported by objective observations or measurements. Non-random (biased) associations may arise if subjects with or without symptoms have a different recall of exposures, or if those with exposures that worry them pay more attention to their symptoms (Viikari-Juntura et al. 1996; Walker-Bone et al. 2005). In addition, the assessment methods for psychosocial risk factors vary, because there is a poor consensus about how these factors should be measured. Several reviews have noted that there is a lack of consistency in how key aspects of the psychosocial environment, such as job demands, autonomy, and workplace support and job satisfaction, are measured in individual studies (Macfarlane et al. 2009). There is also variation in both the domains investigated and the approach to collecting domain-specific data.

Physical load is assumed to have both an acute and a cumulative effect on the occurrence of back pain (Hoogendoorn et al. 1999). A load that exceeds the failure tolerance of the tissue, even if only applied once, can cause back pain. However, the cumulative load resulting from lower magnitude loads may be even more important. In such cases, back pain is assumed to be the result of a repeated application of loads or the long-term application of a sustained load.

Pain is the main symptom in most MSD and the objective findings are usually based on functional restrictions caused by pain. Pain perception, on the other hand, is dependent on many individual, psychological and social factors, instead of pathophysiological aspects. Therefore, any given risk factor is unlikely to cause musculoskeletal symptoms or medically verifiable disorders in all employees, but the context partly determines whether disturbing pain is perceived or not.

The effects of the work environment on health may be mediated by at least two pathways, as suggested in the model depicted in figure 3 (Cox et al. 1994). It has been argued that the *physico-chemical* and the *psycho-physiological mechanisms* do not offer alternative explanations, but they are present and interact to different extents in all situations. While many of the effects of the physical environment are mediated directly by the physico-chemical mechanism, anxiety and fear about that environment may also have a psycho-physiological impact. In turn, the effects on health of the psychosocial and organisational environments are largely mediated by psycho-physiological processes, though certain issues, like workplace violence, may have a direct effect through physical injury.

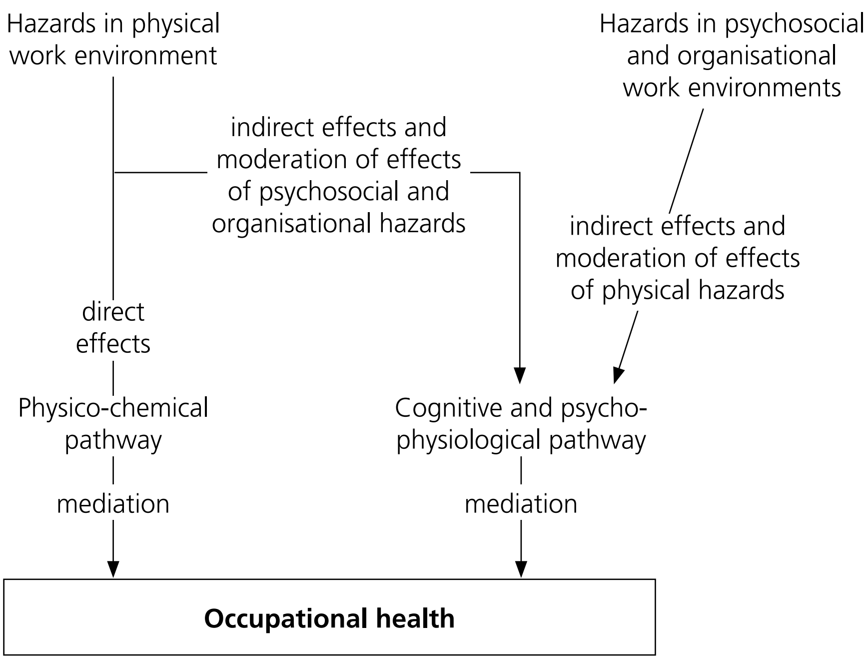

FIGURE 3. Work environment and occupational health: a model suggested by Cox and Ferguson (1994)

Four explanations for the association between psychological work characteristics and musculoskeletal symptoms have been proposed (Hoogendoorn et al. 2000); (1) psychosocial work characteristics can directly influence the biomechanical load through changes in posture, movement and exerted forces; (2) psychosocial work characteristics may trigger physiologic mechanisms, such as increased muscle tension or increased hormonal excretion that may in the long term lead to organic changes and the development or intensification of musculoskeletal symptoms or may influence pain perception and thus increase symptoms; (3) psychosocial factors may change the ability of an individual to cope with an illness which, in turn, could influence the reporting of musculoskeletal symptoms; (4) the association may well be confounded by the effect of physical factors at work.

In systematic reviews on the effectiveness of the work-related interventions, five levels of evidence have been used to summarise the results. Most reviews adapt the classification suggested by the Cochrane Collaboration Back Review Group (van Tulder et al. 2003). According to this classification, *"strong evidence"* refers to consistent findings among multiple high quality randomised controlled trials (RCTs); *"moderate evidence"* refers to consistent findings among multiple low quality RCTs and/or nonrandomised controlled clinical trials (CCTs) and/or one high quality RCT; *"limited"* refers to one low quality RCT and/or CCT; *"conflicting"* refers to inconsistent findings among multiple trials (RCTs and/or CCTs); and *"no evidence"* refers to the fact that no RCTs or CCTs have been identified. This classification was modified quite recently (Furlan et al. 2009) labelling the levels according to the quality of the evidence as "high", "moderate", "low", "very low quality", or "no evidence".

In conclusion, research on MSD faces many challenges related to the appropriate study methods and outcomes, exposure and symptom verification, and the theoretical models explaining the effects of both physical and psychosocial exposures and their interaction. There is a large body of evidence already available, but more high quality research is definitely needed. If the association between work and MSD is related to a greater likelihood of symptoms and disability than the disorder itself, this should be reflected in the prevention activities and ergonomic measures.

3.1.2. Low back pain

Previous research has found over one hundred potential risk factors for LBP (Bakker et al. 2009). A summary of the occupational risk factors of LBP discussed here are presented in table 1.

TABLE 1. Work-related risk factors of LBP

	Risk factors	Reference
Physical risk factors	Manual material handling, including lifting, moving, carrying, and holding loads, as well as bending and twisting; whole-body vibration	(Hoogendoorn et al. 1999)
	Patient handling, high level of physical activity	(Hoogendoorn et al. 1999)
	Whole-body vibration, nursing tasks, heavy physical work, working with one's trunk in a bent and/or twisted position	(Bakker et al. 2009)
	Occupational bending or twisting	(Wai et al. 2009)
Psychosocial risk factors	Low social support in the workplace	(Hoogendoorn et al. 2000)
	High job demands and low job satisfaction	(Macfarlane et al. 2009)
	Low job control and low supervisor support	(Kaila-Kangas et al. 2004)

According to a review of physical load during work as a risk factor for back pain (Hoogendoorn et al. 1999), there is strong evidence that manual material handling, including lifting, moving, carrying, and holding loads, as well as bending and twisting are risk factors for back pain. The magnitude of the risk estimate (relative risk/odds ratio) ranged from 1.5 to 3.1 for manual handling. There is also strong evidence that whole-body vibration is a risk factor for back pain (effect estimate 4.8), and moderate evidence that patient handling and a high level of physical activity are risk factors for back pain with the magnitude of the risk estimates ranging from 1.7 to 2.7 (for patient handling) and from 1.5 to 9.8 (for heavy physical work). In the sensitivity analysis, however, no evidence was found for the effect of heavy physical load (Hoogendoorn et al. 1999).

The results by Hoogendoorn et al. are challenged by a more recent systematic review. This included 18 prospective cohort studies evaluating spinal mechanical load during work and/or leisure time activities as risk factors for nonspecific LBP in patients (>18 years of age) free of LBP at baseline (Bakker et al. 2009). The conclusion was that there are several high quality studies with consistent findings that LBP is not associated with prolonged standing/walking or sitting at work. According to this review, evidence is conflicting for whole-body vibration, nursing tasks, heavy physical work, and working with the trunk in a bent and/or twisted position as risk factors for LBP.

The conclusions of Bakker et al have been criticised (Takala et al. 2010). First, the results of the included studies should be considered as "inconsistent", not "conflicting", because none of the studies indicated that the non-exposed group would have a higher risk than the exposed group. Second, even in studies without statistically significant results, trends did exist for an elevated risk with increased levels of exposure.

Five case-control studies and five prospective cohort studies were included in another recent systematic review on occupational bending or twisting and LBP. The conclusion was that the reviewed evidence was conflicting and not supportive of any clear causal relationship between occupational bending or twisting and LBP (Wai et al. 2009). However, the results did suggest that bending activities involving higher degrees of trunk flexion were associated with disabling types of LBP in certain working populations.

In addition to physical load factors there is also evidence that psychosocial factors play a role in the aetiology of LBP. For symptom-free people, there is strong evidence that individual psychosocial findings are a risk factor for the incidence (onset) of LBP. However, the size of the effect is small (Waddell et al. 2001). A review of reviews has also been published on the associations between workplace psychosocial factors and musculoskeletal pain (Macfarlane et al. 2009). This review claimed that out of the specific work-related psychosocial factors considered, the important factors were job demands, support, job autonomy and job satisfaction. With respect to back pain, the most consistent conclusions (4 reviews positive out of 6) were with high job demands and low job satisfaction. The review emphasised the importance of developing standardised methods for conducting evaluations of existing evidence, and the importance of investigating new longitudinal studies to clarify the temporal relationship between psychosocial factors and musculoskeletal pain in the workplace.

One of the included reviews (Hoogendoorn et al. 2000) found also strong evidence for low social support at work as a risk factor for LBP. However, this result was sensitive to changes in the rating system and the methodological quality of the studies. The authors considered also that the effect for low job satisfaction could be a possible result of insufficient adjustment for psychological work characteristics and physical load at work. They concluded that there seemed to be evidence for an effect of psychological factors at work but that the evidence for the role of specific work-related psychological factors has not been established yet (Hoogendoorn et al. 2000).

Psychosocial risk factors seem to vary according to the type of LBP. In a Finnish prospective cohort study (Kaila-Kangas et al. 2004), low job control and low supervisor support at baseline were associated with increased risk of hospitalisation for back disorders in the 17 year follow-up. There was no similar association for intervertebral disc disorders. Instead, it has been shown in another Finnish study that physically demanding work was a risk factor for sciatica among men (Kaila-Kangas et al. 2009). The risk increased with the length of the exposure for the first 20 years, but decreased thereafter. This study found also a remarkably high prevalence of sciatica among those who were not working. In this group, sciatica was strongly associated with previous work exposures. These results indicate that premature health-related selection out of heavy work had occurred.

The results of physical load exposures as risk factors for LBP in most reviews have been rather insensitive to slight changes in the assessment of the outcomes and the methodological quality of the studies. This, however, does not apply to the results for psychological factors. This indicates that the body of evidence supporting the role of physical load as a risk factor for back pain is somewhat more consistent than that for the psychosocial factors.

3.1.3. Upper extremity disorders

Table 2 shows the known occupational physical risk factors for UED. The most commonly reported risk factors for UED as a group are repetitive movements, force, and hand-arm vibration, whereas psychosocial or work organisational risk factors include high job demand, low decision latitude, low social support, as well as few rest break opportunities (Punnett et al. 2004).

TABLE 2. Work-related risk factors of UED

Diagnosis	Risk factors	Reference
	Physical risk factors	
UED in general	Repetitive movements, force, and hand-arm vibration	(Punnett et al. 2004)
	For men: High level of physical demand, high repetitiveness of task, postures with arms at or above shoulder levels, tasks with full elbow flexion *For women:* Postures with extreme wrist bending and use of vibrating hand tools	(Roquelaure et al. 2009)
Epicondylitis	Repetitive movements of the arms and forceful activities	(Shiri et al. 2006)
	Handling heavy tools or loads, high hand grip forces, repetitive movements, and work with vibrating tools	(van Rijn et al. 2009a)
CTS	Work tasks with vibrating tools, handgrip with high forces, repetitive movements of the hands, and prolonged work with flexed or extended wrist	(Shiri et al. 2009; van Rijn et al. 2009b)
Shoulder pain	Physically strenuous work, working with trunk forward flexed or with a hand above shoulder level	(Miranda et al. 2001)
	Overhead work, repetitive work with shoulder, lifting, pushing or pulling	(Walker-Bone et al. 2005)
Rotator cuff tendinitis	Cumulative working with hand above shoulder level	(Miranda et al. 2005)
Forearm pain	Repetitive tasks	(Macfarlane et al. 2000)
	Psychosocial risk factors	
UED in general	High job demand, low decision latitude, low social support, few rest break opportunities	(Punnett et al. 2004)
	Both high and low job demands	(Macfarlane et al. 2009)
	For men: High psychological demand *For women:* Low level of decision authority in women	(Roquelaure et al. 2009)
Shoulder pain	Mental stress	(Miranda et al. 2001)
	Monotonous work, high job demands and psychological distress	(Andersen et al. 2003)
Forearm pain	Poor satisfaction with level of support from colleagues/supervisor	(Macfarlane et al. 2000)

The risk factors for UED differ according to the specific diagnosis. Handling of heavy tools or loads and repetitive movements are associated with lateral epicondylitis, whereas repetitive movements, forceful activities and working with vibrating tools are risk factors for medial epicondylitis (Shiri et al. 2006; van Rijn et al. 2009a).

Work tasks demanding handgrip with high forces or the use of vibrating tools are associated with an increased prevalence of CTS (Shiri et al. 2009). The association is stronger if these tasks were accompanied by repetitive movements of the hand or wrist. In addition, prolonged work with a flexed or extended wrist has been shown to be a risk factor for CTS (van Rijn et al. 2009b)

Consistent findings have been found for repetitive movements, vibration and duration of employment as occupational risk factors of shoulder pain in a review with 29 cross-sectional studies (van der Windt et al. 2000). Nearly all studies that have assessed psychosocial risk factors have reported at least one positive association with shoulder pain, but the results were not consistent across studies for high psychological demands, poor control at work, poor social support, or job dissatisfaction.

Another review concluded that the work-related risk factors for shoulder pain are overhead work, repetitive work with the shoulder, and lifting, pushing or pulling (Walker-Bone et al. 2005). Evidence suggests that cumulative intensive shoulder work particularly incorporating combinations of exposures is associated with a significantly increased prevalence of shoulder disorders. The work-related factors as predictors of shoulder pain differ according to the nature of the disorder. A prospective study found that mental stress and physically strenuous work, as well as working with trunk forward flexed or with a hand above the shoulder level increased incident shoulder pain, whereas persistent severe shoulder pain was associated with overload at work and working with a hand above the shoulder level (Miranda et al. 2001).

With respect to the psychosocial factors, monotonous work, high job demands and psychological distress were three exposures that have been shown to increase the risk of shoulder pain in a prospective study among workers in industrial and service companies. Furthermore, poor workplace support from colleagues/supervisors and psychological morbidity increase the risk of adhesive capsulitis (Andersen et al. 2003).

The gender of the employee also seems to play a role in risk factors of UED. In a French study where specific UED were diagnosed by trained OH physicians, the risk factors differed between men and women (Roquelaure et al. 2009). High level of physical demands, high repetitiveness of the task, postures with the arms at or above shoulder levels, and tasks with full elbow flexion increased the risk of UED in men. In women, UED were associated with postures with extreme wrist bending and use of vibrating hand tools. Psychosocial risk factors were only modestly associated with UED, high psychological demands in men and a low level of decision authority in women. Another study found similar results and the authors concluded that gender differences in response to physical work exposures may reflect gender segregation in work and potential differences in force producing capacity (Silverstein et al. 2009).

There is evidence that both individual psychological factors (worry and distress) and workplace factors correlate with the onset of pain in UED (Shaw et al. 2002b). The available evidence also suggests that psychological and occupational psychosocial variables have an important role in the aetiology of shoulder pain. In a review of reviews (Macfarlane et al. 2009) there were six reviews conducted on neck/shoulder and forearm pain and psychological factors (altogether 85 individual studies) which concluded that both high and low job demands were associated factors. Low job demands included the job being evaluated as monotonous or with insufficient use of skills.

Non-specific forearm pain has been shown to be associated with repetitive tasks (Macfarlane et al. 2000). In the same study, new onset forearm pain was independently predicted by psychological distress, aspects of illness behaviour, as well as psychosocial factors such as satisfaction with the level of support from colleagues/supervisor. In fact, non-specific shoulder pain seems to be more highly related to psychosocial and individual psychological factors, whereas chronic rotator cuff tendinitis is related to cumulative loading on the shoulder, age and insulin-dependent diabetes mellitus (Miranda et al. 2005; Viikari-Juntura et al. 2008).

As a conclusion, it seems that the more specific the disorder, the more convincing is the evidence that certain physical load exposures at work are risk factors. Psychosocial risk factors seem to play a more significant part in the aetiology of more non-specific UED. Therefore, the challenge in managing work-related UED is to make the correct diagnosis in order to find the best work-related intervention.

3.1.4. Work-related interventions in preventing musculoskeletal disorders

Intervention studies aiming at the prevention of MSD usually include all available employees in the workplace regardless of whether they have had the disorder previously or not. Consequently, it is hardly ever possible to distinguish between primary and secondary prevention studies. The intervention is directed to both those with or without prior symptoms and related disability, and those with present symptoms. These subgroups, however, are usually taken into consideration in the statistical analyses.

Multicomponent interventions have a greater chance than single interventions in their success in reducing work-related MSD according to a comprehensive review (Silverstein et al. 2004). Modifying individual factors is not particularly useful in preventing work-related MSD, but exercise appears to be effective in mitigating some of the consequences. In addition, participatory approaches have been often, though not always, successful.

The review of the evidence on the effectiveness of lumbar supports, education and exercise in the primary prevention of back pain in the workplace was updated in 2004 (van Poppel et al. 2004). According to five new papers added to the eleven previously available trials, there was still no evidence to support the use of lumbar supports or education in the prevention on back pain. Moreover, even when including the results of the new trials, there was still only limited evidence to support the effectiveness of exercise.

Exercise interventions to prevent LBP among employees have an effect on new episodes of LBP according to another systematic literature review on the effectiveness of LBP interventions in the workplace (Tveito et al. 2004). Instead, education, lumbar supports or multidisciplinary interventions showed no support for their effectiveness in preventing back pain. Similar conclusions were reached in another review (Bos et al. 2006): training and education alone were not sufficient to achieve any decrease in musculoskeletal symptoms, but in addition to ergonomic intervention (i.e., the use of additional mechanical or other aid equipment), a decrease of musculoskeletal symptoms could be attained.

A mixed level of evidence was observed for the general question, whether office interventions among computer terminal users have any effect on musculoskeletal or visual health (Brewer et al. 2006). This review included not only RCTs, but studies using different study designs. Moderate evidence was observed for (1) no effect of workstation adjustment, (2) no effect of rest breaks and exercise, and (3) positive effect of alternative pointing devices on musculoskeletal outcomes in comparison to a conventional mouse. Mixed or insufficient evidence of effect was observed for all other interventions.

There is no evidence to support the benefits of production systems/ organisational culture interventions (Boocock et al. 2007). That review identified no single-dimensional or multi-dimensional strategy for intervention that was considered as being effective across occupational settings. Trials have mainly included computer terminal workers and shown only a modest effect of workplace adjustments, exercise and advice as approaches for preventing and managing neck/upper extremity musculoskeletal conditions.

Burton et al (Burton et al. 2009) have concluded that effective interventions for UED require a multimodal approach in which specific treatment would be coupled with workplace accommodation. They also emphasized that an integrative approach by all stakeholders (employer, worker and health professional) was a fundamental requirement in facilitating an early return to work. Others have emphasized the importance of communicating with supervisors. Their needs and challenges have to be identified in addition to tailoring the program to accommodate production, work-task needs, and to be as marginally disruptive as possible (Feuerstein et al. 2006).

In a cluster randomised controlled trial (Haukka et al. 2010) kitchen workers in the intervention group were encouraged to actively participate in work analysis, planning, and implementing the ergonomic changes aimed to decrease physical and mental workload. During the follow-up, no favourable, even adverse, effects on the psychosocial factors at work were found. In addition, these authors have reported previously that there was no evidence for the effectiveness of the intervention in reducing the perceived physical load or preventing MSD (Haukka et al.

2008). However, a significantly reduced risk of future shoulder pain was observed in a subgroup of employees, whose work tasks perceived as the most strenuous were reduced (Pehkonen et al. 2009).

The above mentioned RCT was included in the review on the effectiveness of ergonomic workplace interventions on LBP and neck pain (Driessen et al. 2010). This review accepted only randomised controlled trials, which included interventions targeted at changing the biomechanical exposure at the workplace or on changing the work organisation. The results were that there is low to moderate quality evidence that these kinds of interventions are not any more effective than no ergonomic intervention on short and long term LBP and neck pain incidence or prevalence, short and long term LBP intensity, and short term neck pain intensity. There was low quality evidence that a physical ergonomic intervention (for example, arm board) was significantly more effective on the reduction of neck pain over the long term than no ergonomic intervention.

In conclusion, the results of previous studies on work-related risk factors for MSD have not been confirmed in intervention studies. This is either due to the fact that intervention studies have failed to modify all relevant work-related factors at the workplace, or that musculoskeletal symptoms and disorders are only partly caused by work-related factors, and the other relevant factors are being left outside the scope of the interventions.

3.2. Work-related risk factors of sickness absence

3.2.1. General

Pain and other symptoms caused by MSD can lead to significant personal distress, loss of function and disability. Identifying the factors associated with decreased musculoskeletal function may lead to the development of more effective interventions. Tools for early identification of workers with musculoskeletal symptoms who are at a high risk of prolonged disability would help to focus clinical attention on the patients who need it most, while helping to reduce unnecessary interventions (and costs) among others (Dionne et al. 2005). By targeting specific treatment and rehabilitation to potential high-risk cases early, one could argue that it should be possible to prevent adverse outcomes including unnecessary prolongation of disability.

Clinical practice guidelines have provided useful algorithms for the medical management of LBP, but these do not address certain factors that may influence LBP related disability (Shaw et al. 2001). Based on the evidence that multiple factors contribute to disability, interventions that address medical, workplace, and psychosocial issues should, in theory, be more likely to produce improved outcomes than traditional medical treatment alone.

Attention has to be paid to the fact that a great deal of available evidence on MSD and related disability has focused on disorders considered as being work-related. In many countries this entitles the worker to file a worker's compensation claim followed by the right to free medical care or other benefits. It has been shown earlier that work-related LBP is distinct from similar non-work-related conditions in that a sudden onset is usually reported, and disability outcomes are usually less favourable despite more intensive treatments (Shaw et al. 2005). This same phenomenon is likely to apply to other MSD as well, taking into consideration the significance of the individual's own perceptions on the disability outcome (for more, see chapter 3.4.1.).

According to a Finnish study investigating workers predominantly engaged in physical work (Taimela et al. 2007), self-rated future work ability and perceived musculoskeletal impairment were strong determinants of sickness absence. Among those susceptible to taking sick leave, the estimated mean number of absence days increased by 14 % for each increase of one unit of the impairment score on a scale from zero to ten.

3.2.2. Low back pain

According to the annual statistics of the Finnish Social Insurance Institution, back pain (M40–54 in International Classification of Disease) accounted for 14 % of all compensated disability days, and 40 % of all disability days caused primarily by MSD (Kansaneläkelaitos 2008). The direct financial costs due to back-related disability days was 113 M€ to the Social Insurance Institution (15 % of total costs).

Table 3 shows work-related risk factors of sickness absence due to LBP. There is epidemiological and clinical evidence that care seeking and back disability depend more on complex individual and work-related psychosocial factors than on clinical features or the physical demands of work (Waddell et al. 2001).

TABLE 3. Work-related risk factors of sickness absence due to LBP

	Risk factors	Reference
Physical risk factors	Harmful biomechanical loads	(Wickström et al. 1998)
	Exposure at work to trunk flexion, trunk rotation and lifting	(Hoogendoorn et al. 2002)
	Doing heavy physical work	(Steenstra et al. 2005)
	Heavier occupations with no modified duty	(Shaw et al. 2001)
Psychosocial risk factors	Lack of recognition and respect at work	(Wickström et al. 1998)
	Perceived control and low support at the workplace	(Shaw et al. 2001; Werner et al. 2009)
	Self-reported job demands	(Shaw et al. 2001)
	Low job satisfaction/job dissatisfaction	(Truchon et al. 2000; Hoogendoorn et al. 2002)
Psychological risk factors	Negative beliefs about LBP, poor coping abilities	(Werner et al. 2009)
	Distress (psychological distress, depressive symptoms, and depressive mood)	(Shaw et al. 2001; Pincus et al. 2002)
	Pain avoidance beliefs, pain coping, psychological distress, problem solving orientation	(Shaw et al. 2002b)
	Subjective negative appraisal of one's ability to work	(Truchon et al. 2000)
Other	High level of disability, social isolation, receiving a high level of compensation	(Steenstra et al. 2005)
	Delayed reporting, severity of pain and functional impact, shorter job tenure	(Shaw et al. 2001)

No core set of predictors exists for sickness absence in general, according to a systematic review on evidence of predictors for sickness absence in patients with non-specific LBP (Kuijer et al. 2006). The review studied separately the predictors for absence threshold (i.e., the decision to report sick) and RTW threshold (i.e., decision to return to work). With respect to the absence threshold, no predictors were found for factors predicting sickness absence at the moment of follow-up measurement, and no consistent evidence was found for total number of sick leave days.

In a non-systematic review the determinants of sickness absence due to LBP were studied separately for the characteristics of the sick-listed worker, the characteristics of the sick-listing person (the doctor), workplace, and the cultural and economic conditions of the society (Werner et al. 2009). This evidence shows that negative beliefs about LBP, comorbidities, and poor coping abilities seem to be the most important determinants for claiming sick leave for LPB. Moreover, the doctor will usually follow the patient's demands to be given sick leave. The employee's perceived support and control at the workplace seem to be of importance in preventing sick leave. National differences in economic compensation for sick leave appear to be associated with differences in rates of sickness absence.

According to the results of a Finnish study, the take-up of sick leave attributed to LBP was predicted by exposure to harmful biomechanical loads (rate ratio 3.1). In addition, lack of recognition and respect at work predicted sick leave caused by LBP (rate ratio 2.0) (Wickström et al. 1998).

Self-reported job demands appear to be better predictive of disability than more objective job assessment measures (Shaw et al. 2001). Worker self-reports of greater physical demands of the job appear to be predictive of chronic LBP disability, whereas more objective measures of physical demands are not. Although worker perceptions of ergonomic exposure may differ from more objective workplace assessment strategies, both are subject to error, but worker report appears to be more strongly correlated with disability outcomes. The authors concluded, that self-reports may be more accurate in identifying unusual or high risk demands. However, the modest correlation between pain, functional limitations, and work disability suggests that these outcomes may develop somewhat independently from each other during the recovery period following acute LBP (Shaw et al. 2009a).

According to a review on psychological factors as predictors of chronicity/disability, the most consistent finding was that distress (psychological distress, depressive symptoms, and depressive mood) is a significant predictor of unfavourable outcome, particularly in primary care (Pincus et al. 2002). This effect was independent of clinical factors, such as pain and function at baseline. In addition, there was moderate evidence for somatisation having a role in the progression to persistent symptoms and/or disability, but the effect size was found to vary. The authors concluded that psychological factors play an important role in the transition to chronic LBP, and that they may contribute at least as much as clinical factors.

A number of psychological variables have been shown to mediate the functional limitations of MSD, especially chronic LBP. These factors include pain avoidance beliefs, pain coping, psychological distress, and problem solving orientation (Shaw et al. 2002b).

In a 3-year prospective cohort study on risk factors of sickness absence due to LBP (Hoogendoorn et al. 2002), significant rate ratios, ranging from 2.0–3.2, were found for exposure at work to trunk flexion, trunk rotation, lifting, and low job satisfaction. In addition, non-significant rate ratios of about 1.4 were found for low supervisor support and low co-worker support.

In a review with only inception cohort studies (Steenstra et al. 2005), the patients with LBP with the highest risk for long term absence were older females characterised by radiating pain, high level of disability and social isolation, doing heavy physical work, and receiving a high level of compensation. It seems that in spite of the effect of history of LBP on recurrences of back pain, a history of LBP does not influence the duration of sick leave due to LBP.

A systematic review of studies on the biopsychosocial factors predictive of not returning to work due to LBP examined 18 prospective studies (Truchon et al. 2000). The work-related predictive factors were a subjective negative appraisal of one's ability to work and job dissatisfaction. The importance of certain psychological variables, like attitudes and beliefs, as well as coping strategies, was also emerging.

A review of studies assessing the value of various prognostic factors to predict extended disability after an acute episode of "occupationally attributed" LBP found that significant prognostic factors include low workplace support, personal stress, shorter job tenure, prior episodes, heavier occupations with no modified duty, delayed reporting, severity of pain and functional impact, radicular findings, and extreme symptom reporting (Shaw et al. 2001).

It is logical that clinical data alone does not predict reliably the risk of sickness absence in LBP. Pain as a subjective experience and functional limitations in relation to work demands may complicate the possibilities to continue working. More research is needed to create alternative methods of supporting working despite the presence of LBP, taking into account the cumulating evidence of the benefits of staying active in the management of MSD.

3.2.3. Upper extremity disorders

UED cause remarkable disability resulting in lost productivity. For example, in Washington State in 1990–1998, the average time lost from work was 170–251 days per compensation claim related to UED (Silverstein et al. 2002).

A cross-sectional study was performed among workers representing a variety of occupations but sharing a common workers' compensation and employee health benefit program (Shaw et al. 2002b). The results showed that factors other than pain explained twice as much variability in upper extremity functional limitation as explained by pain alone. This suggests that functional limitation may persist somewhat independently of pain amelioration. After controlling for pain and gender in a multiple regression analysis, the factors contributing to functional limitation were non-pain related upper extremity symptoms (for example, sleep disturbance, numbness, tingling), symptoms in both hands, feelings of being overwhelmed by pain, low confidence in problem solving abilities, and higher ergonomic risk factor exposures at work.

3.2.4. Prevention of sickness absence caused by musculoskeletal disorders

This chapter evaluates interventions aiming at reducing the frequency of musculoskeletal sickness absence (total number of spells/all employees) or the length of musculoskeletal sickness absence (sick-leave days/sick-listed persons).

The treatment chosen by the physician is crucial for the recovery process. A controlled trial showed that as little as two days of bed rest instructed by the physician lead to a slower recovery than the avoidance of bed rest, as well as to longer sick leaves (Malmivaara et al. 1995). This study of workers with acute LBP suggests that avoiding bed rest and maintaining ordinary activity lead to the most rapid recovery.

Screening for medical "red flags" and diagnostic triage is important in the exclusion of serious spinal diseases and nerve root problems (Waddell et al. 2001). Since individual and work-related psychosocial factors play an important role in the persistence of symptoms and disability, screening for "yellow flags" can help to identify those workers with LBP who are at risk of developing chronic pain and disability. Later the system of "yellow flags" was refined and workplace factors were categorised either as "black flags" including actual workplace conditions that can affect disability, or "blue flags" including individual perceptions about work, whether accurate or inaccurate, that can affect disability (Shaw et al. 2009b).

Blue flags have been conceptualised as worker perceptions of a stressful, unsupportive, unfulfilling, or highly demanding work environment. Black flags include both employer and insurance system characteristics as well as objective measures of physical demands and job characteristics (Shaw et al. 2009b). It has been claimed that a better understanding of the meaning (thoughts, beliefs and attitudes) that patients attribute to their pain could be a critical step toward improving return to work outcomes (Loisel et al. 2005).

Although working conditions with uncomfortable working positions, lifting or carrying loads, pushing and pulling loads as well as the use of vibrating tools, have all been found to be associated with sickness absence, it has been stated that many years of implementing ergonomic adaptations have not reduced the incidence of sickness absence (Werner et al. 2009).

A Cochrane review (van Oostrom et al. 2009) has been published focusing strictly on randomised controlled trials. The results showed that when compared to usual care, there is moderate-quality evidence to support the use of workplace interventions carried out close to the workplace and in collaboration with the key stakeholders in order to prevent work disability and reduce sickness absence among workers with MSD. No evidence was found for the benefits of workplace interventions on health outcomes (for example, pain or functional status). This was considered as support for the hypothesis that RTW and resolution of symptoms are not equivalent. In other words, workplace interventions tend to address the work disability problem and not the underlying medical problem.

The supervisors' role in the management of musculoskeletal pain has been evaluated in a controlled case study (Shaw et al. 2006). Eleven supervisors in an intervention group and 12 supervisors in a delayed intervention control group from the same plant were provided with two 2-hour training workshops separated by 4 to 7 days. The fundamental message in the workshops was that supportive, proactive, and collaborative communications with employees about ergonomic risk factors and musculoskeletal pain and discomfort would be likely to reduce disability costs and improve employee morale, productivity and retention. Workers' compensation claims data in the seven months before and after the intervention showed a 47 % reduction in new claims and an 18 % reduction in active lost-time claims versus 27 % and 7 %, respectively, in the control group. According to that study, improving the response of frontline supervisors to employees' work-related health and safety concerns could achieve sustainable reductions in injury claims and disability costs.

Based on interviews with 30 employees Shaw et al. (2003b) developed 11 common themes for the role of supervisors to prevent workplace disability after injury: accommodation to reduce ergonomic risks or discomfort, communicating with workers, responsiveness, concern for welfare, empathy/support, efforts to understand the employee's situation, fairness/respect, follow-up, shared decision making, coordinating with medical providers, and obtaining co-worker support of accommodation.

Several studies performed in different countries have shown a mismatch between public beliefs about back pain and current scientific evidence (Buchbinder et al. 2008). Since beliefs and attitudes about back pain are associated with the development of chronicity, it is apparent that strategies are needed that align public views with current evidence. Media campaigns in Scotland and Norway highlighting the awareness of staying active through an episode of LBP did not change sickness behaviour despite improved beliefs in the general public. However, an earlier campaign in Australia was followed by a clear decline in the number of claims for back pain, rates of compensated days and costs of medical care. The possible explanation for this is that only in Australia were specific advertisements aimed at employers showing the benefits of reintegrating employees, the importance of modified work, and the penalties involved for noncompliance (monetary fines).

In Norway, in addition to a media campaign aiming at improving beliefs about LBP in the general public, a project trained peer advisers in six participating workplaces (Werner et al. 2007). The task of this peer adviser was to provide information aimed at reducing fear of the pain, supportive advice, and arranging for modifications of workloads for a limited period of time. Even though the prevalence of back pain remained constant throughout the study period (three years), the combination of peer support given by a trained foreman, union leader or personnel officer and modified workload seemed to have supplemental effects to a general media campaign in reducing sickness absence due to LBP and improvements in beliefs about back pain.

3.3. Work-related determinants of sickness presenteeism

In the recent past, the worker's ability or capacity to produce goods or deliver services while suffering from MSD has been of particular interest in the area of occupational research. Escorpizo has proposed that work productivity within the context of work-related MSD is determined by the health condition itself, the capacity, desire and difficulty of working, as well as work-life balance and non-occupational factors (Escorpizo 2008). The measurement of work productivity is crucial to initiating, evaluating, and monitoring disability management, for example, employee wellness and ergonomic programs, and clinical interventions in the management of MSD.

In a Finnish postal survey of labour union members (Böckerman et al. 2009), presenteeism ("present at work in spite of sickness") was associated with permanent full-time work, shift or period work, regular overtime, overlong weekly working time, and efficiency requirements at work. On the other hand, lower levels of presenteeism were associated with the possibility of replacement by a substitute, match between desired and actual working hours, and the possibility of taking a short sick leave without the need for sickness certificate.

According to a systematic review on employee health and presenteeism (Schultz et al. 2007a), the studies in the literature focusing on MSD are surprisingly rare. Most of the earlier studies have assessed productivity loss related to self-reported symptoms, whereas there is a very limited number of studies on productivity loss associated with clinically diagnosed MSD. The nature of the musculoskeletal condition presumably affects productivity, and the risk factors for productivity loss related to various disorders may vary. Little is known of the effects of the musculoskeletal diagnoses on productivity loss.

Some North-American surveys on presenteeism have not focused only on MSD but also on other health conditions. Among workers participating in a telephone survey measuring both absenteeism and reduced performance due to common pain conditions, those reporting back pain had average lost productive time of 5.2 hours per week (Stewart et al. 2003). The majority (77 %) of the lost productivity due to any pain condition was explained by reduced performance while at work and not by work absence. In another survey (Loeppke et al. 2007), back or neck pain was the top medical condition accounting for annual medical, drug, and productivity loss costs per 1000 full time employees in all types of companies.

Table 4 lists the known work-related determinants of sickness presenteeism due to MSD. Poor health has been proposed to be a prerequisite for sickness presenteeism. In addition, several other factors related to work and personal circumstances have also been associated with presenteeism, such as low replaceability or high attendance requirements, for example, having to compensate for all work not done after a period of absence, lack of work resources, time pressure, job stress, job insecurity, and long work hours (Bergström et al. 2009). Personal factors, despite having a somewhat weaker relation to presenteeism than work factors, included financial problems, lack of individual boundaries, over-commitment to work, conservative attitudes toward sickness absence, age and limited education (Bergström et al. 2009).

TABLE 4. Work-related determinants of sickness presenteeism

	Determinants	Reference
Individual factors	Poor health, financial problems, conservative attitudes toward sickness absence, age, limited education	(Bergström et al. 2009)
	Worse physical health, more functional disability	(Lötters et al. 2005)
	Musculoskeletal complaints, worse physical, mental and general health, recent absenteeism	(Meerding et al. 2005)
	Physical exercise fewer than 8 times during the last month	(Hagberg et al. 2002)
Work-related factors	Permanent full-time work, shift or period work, regular overtime, overlong weekly working time, and efficiency requirements at work	(Böckerman et al. 2009)
	Low replaceability or high attendance requirements at work for example, having to compensate for all work after a period of absence, lack of work resources, time pressure, job insecurity, and long work hours	(Bergström et al. 2009)
	Working overtime, computer mouse use for more than 0.5 h/day	(Hagberg et al. 2002)
Psychosocial and psychological factors	Job stress, lack of individual boundaries, over-commitment to work	(Bergström et al. 2009)
	Poorer relations with the supervisor	(Lötters et al. 2005)
	Job demands	(Hagberg et al. 2002)

Reduced productivity after 2- to 6-week sickness absence due to MSD was quantified in a prospective cohort study using self-administered questionnaires (Lötters et al. 2005). Reduced productivity was prevalent for 60 % of the workers after they returned to work, and for 40 % still at the 12-month follow-up. Worse physical health, more functional disability and poorer relations with the supervisor were associated with productivity loss shortly after return to work. Recurrent sick leave was the greatest predictor of productivity loss at the follow-up.

Two questionnaires on productivity loss ("Health and Labor Questionnaire" and "Quantity and Quality") were compared among two populations doing jobs with high physical effort (Meerding et al. 2005). About half of the workers with health problems on the last working day reported reduced work productivity. This was significantly associated with musculoskeletal complaints, worse physical, mental and general health, and recent absenteeism. Self-reported productivity using a Quantity and Quality (QQ) instrument correlated significantly with objective work output.

In a Swedish study (Hagberg et al. 2002) among white-collar computer users 8 % of all employees reported reduced productivity due to musculoskeletal symptoms. The mean magnitude of reduction was 15 % for women and 13 % for men. Working overtime and job demands were risk factors for self-reported reduced productivity due to neck and back symptoms, whereas physical exercise fewer than 8 times during the last month was a risk factor for productivity loss due to neck, shoulder and upper limb pain (Hagberg et al. 2007). In addition, computer mouse use for more than 0.5 h/day was a risk factor for reduced productivity owing to shoulder and upper limb symptoms.

In a study of 654 computer workers with neck/shoulder or hand/arm symptoms (van den Heuvel et al. 2007), productivity loss was involved in 26 %, and more often (36 %) in cases reporting both neck/shoulder and hand/arm symptoms. Most of the productivity loss in the arm/hand cases was due presenteeism and sickness absenteeism was present in only 11 % of the cases. Overall productivity loss was associated with pain intensity, high effort regardless of the reward level, and low job satisfaction.

In a one-year follow-up study among 771 young adults who reported neck or upper extremity symptoms, but no productivity loss at baseline, the risk factors of productivity loss were symptoms in several locations, longer persistence of symptoms, and computer terminal use of 8–14 hours/week during leisure time (Boström et al. 2008). A stronger relationship was found if three or four risk factors were present.

In addition, several studies have found, somewhat unexpectedly, that the younger employees report more health-related productivity loss than older employees (Hagberg et al. 2002; Collins et al. 2005; Alavinia et al. 2009).

3.3.1. Prevention of sickness presenteeism associated with musculoskeletal disorders

In a Dutch study (van den Heuvel et al. 2003), workers with complaints in the neck or upper limb were randomized into a control group, one intervention group encouraged to take extra breaks, and another intervention group encouraged to perform exercises during the extra breaks. After an 8-week period, the subjects in the intervention group with breaks only showed higher productivity (more key strokes) than the control group. The stroke accuracy rate in both intervention groups was higher than in the control group. However, there were no significant differences between the three groups in the reported severity or frequency of the complaints before and after the intervention.

In another study (Rempel et al. 2006), a group of computer terminal workers in the United States was randomised to receive ergonomics training only, training plus a trackball or forearm support, or training and both a trackball and a forearm support. Despite the fact that the forearm support combined with ergonomic training seemed to prevent upper body musculoskeletal symptoms, there were no significant differences between the intervention groups in either the company tracked productivity measures or in self-assessed productivity.

Cost-effectiveness of an active implementation strategy for the Dutch physiotherapy guideline for LBP has been studied in a RCT including also productivity costs as an outcome measure (Hoeijenbos et al. 2005). About half of the patients at baseline reported productivity loss due to LBP corresponding to almost 2 hours on average per day. Compared to baseline, significantly more patients were seen without any productivity loss in both the intervention and control group after 6 (56 % and 64 %, respectively) and 12 weeks (71 % in both groups). The differences between the two groups, however, were not statistically significant.

3.4. Determinants of return to work

The primary goals of employee rehabilitation and RTW programs may appear to be the payer's interest in reducing disability costs, but there are additional incentives: human rights legislation in many countries prohibits discrimination in employment practices on the basis of disability status (Brooker et al. 2001).

According to a systematic review of the quantitative literature on workplace based RTW interventions, there is strong evidence that work disability duration is significantly reduced by work accommodation offers and contact between healthcare provider and the workplace (Franche et al. 2005). Moderate evidence was found that disability duration is also reduced by interventions which include early contact with the worker by the workplace, ergonomic work site visits, and the presence of a RTW coordinator. Thus, for these five intervention components, there was moderate evidence that they reduce costs associated with work disability duration but there was insufficient or limited evidence for the sustainability of these effects.

A consensus panel of 33 researchers and stakeholders selected key factors in back disability prevention following a literature search on the assessment of which factors that predict or determine disability (Guzman et al. 2007). Existing research evidence had largely focused on RTW. Among the factors with a high impact on occupational participation were care provider reassurance (strong consensus), expectation of recovery and decreased fears (moderate consensus), and increased knowledge of the individual with back pain and appropriate medical care (low consensus). On the other hand, there was major disagreement as to the impact of increased job satisfaction, decreased pain, increased fitness, improved function, improved workstation design, decreased physical workload, and lifting devices.

Many of the RTW studies have been carried out in North America with the setting being a worker's compensation system. Therefore, it has been claimed that there is a need for comparative data from other jurisdictions with different insurance schemes and social policy frameworks incorporating alternative legislative imperatives and economic incentives (Brooker et al. 2001). This information could clarify the relationship between societal factors and the availability and quality of workplace-based RTW programs.

The barriers of recovery and RTW were investigated among employees with work-related UED (Shaw et al. 2003a). Case managers identified up to 21 barriers per case within five domains: signs and symptoms (36 % of all barriers), work environment (27 %), medical care (13 %), functional limitations (12 %), and coping of the employee (12 %).

In a 2-year prospective cohort study among patients with back pain in primary care settings, the outcome measure was "RTW in good health" at 2 years combining patient's occupational status, functional limitations and recurrences of work absence (Dionne et al. 2005). The best predictive model included seven baseline variables, such as the patient's recovery expectations, previous back surgery, pain intensity, and difficulty in sleeping. This model was particularly efficient at identifying those patients with no work-related functional problems.

3.4.1. Worker perceptions and expectations

A systematic review (Kuijer et al. 2006) gathered evidence for predictors of the decision to return to work ("RTW threshold"). Consistent evidence was found for own expectations of recovery in that patients with higher expectations of recovery had less sickness absence days at the moment of follow-up measurement.

The importance of psychosocial factors on RTW was studied in a systematic review (Iles et al. 2008) which evaluated 24 studies. These studies produced strong evidence that recovery expectation and moderate evidence that fear-avoidance beliefs would be predictive of work outcome in non-chronic, non-specific LBP. Workers' own beliefs that their LBP was caused by work and their own expectations about their inability to return to work were claimed to be particularly important (Waddell et al. 2001).

Non-medical factors, especially those related to workplace concerns, perceptions of injury severity, and expectations for recovery, were associated with back disability duration in an inception cohort study (Shaw et al. 2005). Patients (183 female, 385 male) suffering a recent onset LBP completed a questionnaire, and after the initial visit the clinicians completed an additional questionnaire. Functional limitation and work status were assessed one month after the pain onset. According to the results of that study, psychosocial factors seemed to moderate the disabling effects of pain, even within the first weeks after pain onset. According to the available evidence, subjective interpretations and appraisals of patients would be more powerful predictors of post back injury recovery than physical examination variables (Shaw et al. 2005).

Individuals' subjective perceptions of personal and environmental issues influence RTW. It was stated that the personal meaning of disability and RTW relevancy would be two key constructs in understanding RTW from the individual's perspective (Shaw et al. 2002a). Throughout the experience of becoming better and returning to work, the workers assessed the impact of personal and external factors that contributed to their work disability. They also evaluated their performance capabilities, and examined the importance of work and the consequences of work disability within their life circumstances.

Based on theories of fear and avoidance behaviour, Waddell et al. postulated that patients' beliefs about how physical activity and work affect their LBP are strongly related to sickness absence due to LBP (Waddell et al. 1993). In a more recent longitudinal study the beliefs about back pain were studied in relation to recovery rate over 52 consecutive weeks (Elfering et al. 2009). Higher levels of work-related fear-avoidance beliefs (i.e., beliefs regarding the inevitable consequences of LBP in the future) predicted greater weekly LBP and impairment. Faster recovery and pain relief over time were seen in those who reported less work-related fear avoidance and fewer negative back beliefs.

In a study of patients with operatively treated hand disorders or injuries (Opsteegh et al. 2009), three factors, i.e. higher pain intensity, accident attributed to work and symptoms of post-traumatic stress, were the most important determinants of delayed RTW. In another prospective cohort study (Baldwin et al. 2007), baseline physical functioning and overall mental and physical health status were more predictive of specific patterns of post-injury employment than pain intensity measures.

3.4.2. Work environment and work organisation

Psychosocial and physical work environment risk factors were examined as predictors of RTW in a Danish prospective study (Labriola et al. 2006). Contrary to previous studies, no significant association was found between workplace size and the three RTW outcomes (RTW within four weeks/one year of the onset of sickness absence and duration of sickness absence). Low meaning of work, stooping or twisting the back, lifting heavy loads and repetitive job tasks significantly decreased the chance of RTW within four weeks of the onset of sickness absence. The chance of RTW after one year of sickness absence was decreased by being exposed to a stooped work position and having to do repetitive job tasks. The duration of sickness absence was prolonged by low skill discretion, low meaning of work, lifting heavy loads at work, and pushing and pulling.

Modified duty and workplace accommodations have been shown to prevent prolonged work absences for workers with MSD by decreasing exposure to normal work demands after medical evaluation and treatment. This was the main finding of a review on the basis of 13 high quality studies (Krause et al. 1998). Injured workers who were offered modified work returned to work about twice as often as those who were not given this option.

A later report strengthened the evidence that workplace offers of arrangements to help the worker return to work are associated with reduced compensation benefit duration (Brooker et al. 2001). The accommodation could be achieved in several ways, i.e. modified or alternate tasks, graded work exposure, work trials, workstation redesign, activity restrictions, reduced hours, or other efforts to temporarily reduce physical work demands. A key concern from the worker's perspective is that modified work arrangements provide a safe workplace environment that facilitates recovery from injury rather than exacerbating it. It was reported that any intervention that reduces absence from regular work was likely to reduce long-term chronicity, with all of its personal and financial costs (Loisel et al. 1997).

The role of a supervisor is vital for the successful RTW of an employee. According to the existing evidence, the interpersonal aspects of supervision may be as important as physical work accommodation to facilitate RTW after injury (Shaw et al. 2003b). A systematic review of the qualitative literature on return to work after injury has been published in order to better understand the dimensions, processes, and practices of RTW (MacEachen et al. 2006). That review noted the relevance of recognising the complexities related to beliefs, roles and perceptions of the many players. Goodwill and trust were the crucial conditions that were central to successful RTW arrangements. In addition, it was observed that there are often social and communication barriers to RTW and intermediary players have the potential to play a key role in facilitating the process.

It has been claimed that the most effective approaches to disability prevention are those that maintain an open and effective communication among workers, physicians, and employers in order to facilitate a smooth and broadly supported reintegration into the workplace (Shaw et al. 2005). Thus, employers who provide a supportive and accommodating approach to disability management may not be able to only reduce disability costs but also improve worker perceptions of their functional health after the injury.

In a study of case management service for work-related UED (Shaw et al. 2004), the types of accommodations obtained by case managers appeared to be relatively inexpensive and included a full range of environmental, equipment, and administrative changes. These accommodations were consistent with reducing upper extremity pain, either directly by addressing workstation design (for example, keyboard, desk edges) or indirectly by altering the work process (for example, breaks, job rotation). In another report from the same study (Lincoln et al. 2002), the accommodations were classified into the following eight general categories: administrative, computer-related, furnishing, workstation layout, environmental, accessories, lifting/carrying aids, and personal protective equipment.

Being contacted by someone from the workplace was not associated with a reduction in time receiving compensation benefits (Brooker et al. 2001). It is likely that merely contacting the worker in the absence of other interventions is not associated with a faster return to work. Alternatively, perhaps the nature of the contact that occurred during the study was not conducive to facilitating a faster return to work. Although workers who were offered modified work tended to receive compensation benefits for a shorter time, they did not seem to have reduced pain scores (Brooker et al. 2001). In fact, a small minority of workers experienced substantially more pain than expected when they resumed their work. The authors of that report recommended that worker and workplace assessments before and after the return of the worker to work may help to ensure that employees are not returned to work too early or to workplace situations that reactivate their pain.

3.4.3. Role of the medical provider

Treatment studies on acute LBP have reported one-month RTW rates from 70 to 90 % depending on recruitment procedures and initial risk factors. This rate has shown remarkable consistency despite jurisdictional differences in employment and disability benefits (Shaw et al. 2005). A high rate of RTW should not be interpreted as a complete resolution of pain, since most employees continue suffering from pain and related productivity loss at work (Shaw et al. 2009a).

According to the results of a literature review (Hlobil et al. 2005), the optimal RTW intervention for subacute LBP might be a mixture of exercise, education, behavioural treatment, and ergonomic measures, but it was not clear which component, or which combination of components, was the most effective. The same review concluded that RTW interventions used in the earlier, acute phase of LBP did not appear to be effective with respect to absence from work. This may be because of the favourable, self-limiting course of LBP and absence from work during this acute phase.

A population-based RCT on back pain management (Loisel et al. 1997) concluded that changes to jobs and workstations using participatory ergonomic approach were preferable to worker-focused strategies such as work hardening (alternating days at the original job with progressively increased tasks and days receiving functional therapy). In that study, an integrated clinical-occupational model of management of back pain was two times more effective in increasing the rate of return to regular work than the usual medical care.

There is also moderate evidence that the presence of a RTW coordinator would be associated with a significant reduction of work disability duration (Franche et al. 2005). Six preliminary competency domains of RTW coordinator activities have been identified (Shaw et al. 2008): (1) ergonomic and workplace assessment; (2) clinical interviewing; (3) social problem solving; (4) workplace mediation; (5) knowledge of business and legal issues; and (6) knowledge of medical conditions.

Professional case managers may be the solution to many of the communication problems involved in disability management. These individuals could identify barriers to RTW, restore normal communication between employer and employees, and engage the medical provider in this process (Pransky et al. 2004). The nurse case manager may successfully legitimise the patient's viewpoint and thus initiate a bidirectional dialogue about RTW directly with the employer. Thus, it was claimed that it was this restoration of communication more than any other intervention that may have accounted for the successes of this model. However, as patients are not accustomed to communicate their concerns, preferences, and expectations, patient training would be desirable to achieve fully effective bidirectional interchange (Pransky et al. 2004).

Participatory ergonomics has been seen as one promising approach to rehabilitation of workers suffering from MSD. Loisel et al. have described a program with four steps (Loisel et al. 2001): First, the ergonomist meets the worker to collect data on personal characteristics. Job descriptions are sought from both the worker and his/her supervisor. Secondly, a meeting is organised in the workplace with the worker and the supervisor to compare the job descriptions, make a list of the risk factors for back pain, and to identify work organisation and job demands relevant to the back pain. Thirdly, the ergonomist visits the workplace to observe the work tasks performed by another worker. Finally, the participatory work group meets to identify improvements in the work tasks. Final acceptance of these solutions is the employer's responsibility.

Ergonomic job modification as a component of a RTW rehabilitation program is generally believed to have positive effects with workers having sickness absence due to back pain (Silverstein et al. 2004). It has been shown, however, that doctor-patient communications about the workplace and RTW are important, but not sufficient in the absence of ergonomic and organisational changes in the workplace (Dasinger et al. 2001; van Duijn et al. 2005). Therefore, RTW coordinators as part of health services have been claimed to represent an effective strategy for promoting RTW. According to a literature review (Shaw et al. 2008), the principal activities of RTW coordination involve workplace assessment, planning for transitional duty, and facilitating communication and agreement among stakeholders.

In order to promote recovery and early RTW, part-time sickness absence is possible in some countries (for example, Finland, Sweden, Norway, and Denmark). However, the effectiveness of part-time sick leave has been poorly studied (Kausto et al. 2008). A Norwegian cluster-randomised study on "active sick leave" (return to adjusted work supported by social security after conventional sick leave had lasted 16 days or more) showed no beneficial effects, partly because the part-time sick leave system was so seldom used (Scheel et al. 2002).

Almost all individuals taking part-time sick leave do seem to be content with this arrangement; 92 % of employees on part-time sick leave in a Swedish survey expressed satisfaction (Sieurin et al. 2007). Two–thirds of those on full-time sick leave considered part-time sick leave as a potentially good alternative for them. However, some disadvantages have also been detected: a Swedish study with a follow-up of 1.5 years found that part-time sick leaves tended to last longer than conventional sick leaves (Eklund et al. 2004).

4. CONCEPTUAL FRAMEWORK OF THE STUDY

The conceptual framework for the study is presented in figure 4. A healthy employee might develop symptoms or disorders during employment (step A). In a case of symptom development, the condition either allows the employee to continue working or alternatively the employee may be absent from work (step B). While at work with the disorder, the employee may have full capacity to perform work duties or he/she might experience impaired functioning to such a degree that productivity at work is reduced (step C). Those who become sick-listed either return to work or their disability becomes prolonged, even permanent (step D). This thesis aims to study these four steps using MSD as an example.

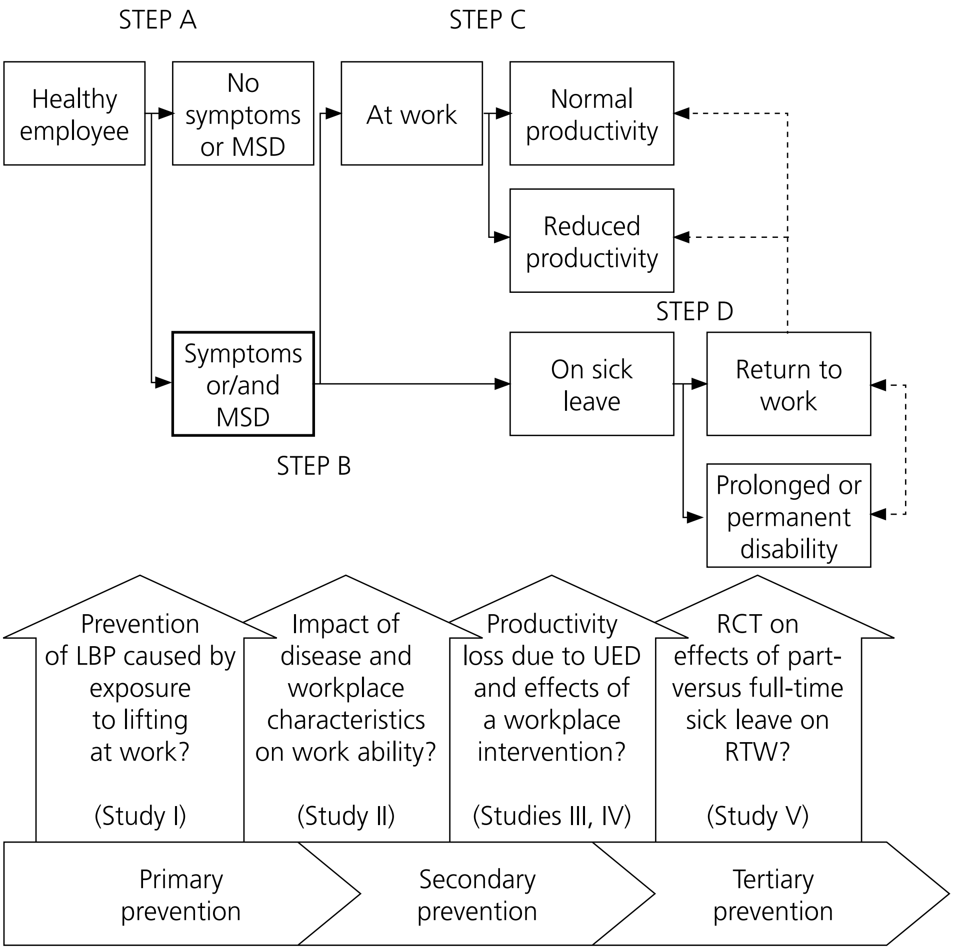

FIGURE 4. Theoretical framework of the study and the research questions

Step A

There is a wealth of reports in the medical literature on the health risks that work can pose to an employee. The aim of occupational safety legislation is to safeguard the health and safety of the employees through risk identification, elimination of risk, or management of the residual risk, if the risk cannot be fully eliminated.

Health problems in working age adults, however, are not fully preventable. There is a high background prevalence of musculoskeletal symptoms even in the general population, and work can have a role as an additional risk factor for MSD (Waddell et al. 2006). According to the general principles of prevention in the EU framework directive on health and safety at work (89/391), combating the risks at source and adapting the work to the individual should always be given priority over individual protective measures and instructions to the workers.

Step B

The disorder may cause impairment in the activity and participation domains of the ICF model. At work, this typically means that the employee cannot continue working, but instead remains absent from work. Contextual factors seem to play a major role in this process (Johansson et al. 2004; Shaw et al. 2009b). It has been shown that (long-term) sickness absence and disability due to MSD depend more on individual and work-related psychosocial factors than on biomedical factors or the physical demands at work (Walker-Bone et al. 2005).

Step C

Sickness absenteeism as a reflection of disabling health condition is one of the major outcomes applied in OH research. During the last years, however, more attention has been paid to the impact of health conditions among those employees who continue at work. The fact that health problems cause interference with work has been verified lately, and the term sickness presenteeism has been introduced to clarify this phenomenon.

Step D

Absence from work is beneficial for the recovery from certain illnesses. In MSD and mental disorders, however, it is obvious that prolonged sickness absence is a major risk factor for permanent disability. Again, this is largely not explained by medical grounds, but psychological and contextual factors are essential in the RTW process (Loisel et al. 2005).

In order to avoid the negative consequences of prolonged sick leave, the disability has to be managed separately from the management of the medical condition itself. The risk factors and, hence, the means to enhance RTW process are different from those of the underlying health disorder.

5. STUDY QUESTIONS AND HYPOTHESES

1. **Can the increased risk of LBP associated with heavy lifting at work be reduced by training the employees in correct lifting techniques or assistive devices?** (Study I)

Based on the available evidence on manual material handling as a risk factor for LBP, the hypothesis evaluated in this systematic review was that training correct techniques in lifting heavy loads at work and/or assistive devices could reduce the risk of back injury (Step A).

2. **What is the impact of disease and workplace characteristics on perceived work ability among employees seeking medical advice?** (Study II)

How do workers visiting their OH physicians with different diseases, and especially MSD, assess their current work ability, and what are the relationships between the workers' perceptions or expectations and self-assessed disability? The hypothesis tested was that perceived partial work ability and work-relatedness of health problems would be common and interrelated (Step B).

3. **How much productivity at work is impaired by medically verified UED?** (Study III)

Productivity loss while at work has been shown to be common among workers reporting musculoskeletal symptoms. The hypothesis for this survey was that diagnosed UED would impair work performance even though actual sick leave would not be needed (Step C).

4. **Can productivity loss at work be reduced by an ergonomic intervention?** (Study IV)

The study hypothesis was that productivity loss at work could be used as an outcome indicator in intervention studies and, during recovery from UED, an individually tailored ergonomic intervention could reduce productivity loss compared to usual medical care (Step C).

5. **How can the effectiveness of part-time sick leave be evaluated in the management of MSD?** (Study V)

The hypothesis was that a randomised controlled trial could be designed and implemented in the Finnish OHS to investigate the effects of part-time sick leave on return to full-time work (Step D).

6. MATERIAL AND METHODS

6.1. Study populations

In all individual studies, the participants were working adults. Studies included in the systematic review (study I) were performed in health or home care (eight studies) or among baggage handlers or postal workers (three studies). The total number of participants in the review was 18 492. Study II included 723 employees from the chemical industry or public sector, whereas 168 to 177 employees in studies III–IV came from the health care and commercial sectors.

There are some differences between the studies with respect to the health status of the study populations and the use of health services (table 5). With the exception of one study (II), in which patients were eligible irrespective of any health problems necessitating a consultation with the OH physician, all other studies (I, III–V) in this thesis include only subjects with MSD.

TABLE 5. Description of the included studies.

	Type of study	Population	Study intervention	Main outcome
Study I	Systematic review	Workers frequently exposed to heavy lifting	Lifting advice and/or devices	LBP and related sickness absence
Study II	Survey (questionnaire)	Workers seeking medical advice at OHS	-	Self-assessed work ability, work-relatedness of the health problem
Study III	Survey (baseline assessment of RCT)	Workers with medically verified UED	-	Self-assessed UED-related productivity loss at work
Study IV	RCT	Workers with medically verified UED	Ergonomic advice and worksite visit	Self-assessed UED-related productivity loss at work
Study V	RCT (protocol)	Workers with medically verified MSD and in need of instant sick leave	Part-time sick leave	Return to full-time work

The systematic review (study I) summarising the evidence on the preventive effects of training and lifting equipment on back pain included studies with employees exposed to heavy lifting at work who were not actively seeking treatment for current back pain.

The survey (study II) included each employee during the study period coming for their first appointment with an OH physician because of any health problem. Studies III and IV focused only on employees with symptoms in the upper extremities and no need for sick leave, whereas study V includes all workers with any MSD necessitating sick leave. The employees were excluded if the condition necessitated medical care in study I, sick leave in studies III–IV, or the pain intensity score was seven or more on a scale from zero to ten in study V; if the disorder was caused by major trauma, infection, or auto-immune disease; if the disorder was complicated by any severe co-morbidity or condition (malignancy, fibromyalgia, mental disorder, occupational injury or disease, scheduled or prior surgery); or the follow-up in studies IV–V would have been complicated by other factors (retirement, pregnancy, or other longer leave from work).

6.2. Methods

The included five studies represent three different types of studies: systematic review, survey (cross-sectional questionnaire and baseline assessment) and RCT (table 5).

6.2.1. Systematic review (Study I)

The current interest in evidence-based medicine has led to an extensive increase in the publication of systematic reviews and to the development of methodological guidelines for systematic reviews, because a systematic approach is known to be less susceptible to bias than a narrative approach (van Tulder et al. 1997; van Tulder et al. 2003).

This systematic review included all studies with interventions that modify techniques for handling heavy objects or patients manually, if the study used back pain, consequent disability, or sick leave as the main outcome. Interventions that were permitted included educational classes, individual training and instructions, posters, leaflets, videos, audiotapes, or combinations of several interventions. In order to find all relevant research reports, the search strategy developed by the Cochrane back review group was utilized (van Tulder et al. 2003). The primary search focused on RCTs with a secondary search on cohort studies with a concurrent control group.

The literature search was carried out between August and November 2005. Search strategies, used databases and the detailed description of the review process are given in the Cochrane Library version of the review (Martimo et al. 2007).

In order to make a secondary analysis using relevant cohort studies with a concurrent control group, the sensitive search strategy for OH intervention studies was applied (Verbeek et al. 2005). Two authors screened the obtained titles and abstracts for eligibility.

The methodological quality of the randomised trials was assessed using the criteria and classification recommended by the Cochrane Back Review Group (van Tulder et al. 2003). The quality of a study was considered as high if more than half of the criteria were fulfilled. For the appraisal of cohort studies, another set of criteria (Slim et al. 2003), validated for non-randomised studies, were used.

The primary analysis of the review was based on the evidence from randomised trials only. In the secondary analysis using the cohort studies, the results of each comparison were summarised in a qualitative manner. Thereafter, the conclusions were compared from the primary and secondary analyses.

6.2.2. Surveys (Studies II–III)

In study II, patients attending a medical consultation at two OH centres (one in chemical industry and the other in public sector in the capital area) were given an anonymous questionnaire before meeting the physician (N=12). Age, gender and occupation were collected together with the response to an open-ended question on the nature and duration of the main disease or symptom that necessitated the consultation. Only the first consultation of each patient during the study period was included.

Patient assessed work-ability (fully or partly able to work, disabled) and work-relatedness of the health problem ("caused or aggravated by work"), and the potential of work-related interventions in alleviating the symptoms. Patients were told that their physicians would not see their responses. The physicians were asked to answer the same questions immediately after the consultation. Only patients who gave the same reason for the visit as indicated by their physician were included in the analysis.

Study III was also carried out in collaboration with three OH units. All subjects aged 18 to 60 years were considered as potentially eligible, if they were seeking medical advice in the occupational health services (OHS) because of upper extremity symptoms that had started or were exacerbated less than 30 days prior to the medical consultation ('early symptoms'). Within three days after seeking medical advice in the OHS, the subject was examined at the Finnish Institute of Occupational Health (FIOH) by a physician, who did not participate in analysing the data. The clinical diagnosis was made by applying standardized diagnostic criteria for each symptom entity (Sluiter et al. 2001).

The outcome of study III was self-assessed productivity loss at work. It was assessed with two questions about the impact of UED on work performance (QQ method) during the preceding full work day (Brouwer et al. 1999). The first question was: ' Assess the impact of your upper extremity symptoms and mark on a scale from 0 ("practically nothing") to 10 ("regular quantity") how much work you were able to perform as compared to your normal workday'. The second question was: 'Assess the impact of your upper extremity symptoms and mark on a scale from 0 ("very poor quality") to 10 ("regular quality") the quality of your work as compared to your normal workday'. The translation of the questions into Finnish was made based on the original Dutch version and its English translation adhering to their wording and style as closely as possible. The validity of the original QQ method has been studied in comparison with other measurements (Brouwer et al. 1999; Meerding et al. 2005). Self-reported productivity on this method has been shown to correlate well with objective work output (Meerding et al. 2005).

A dichotomous variable for productivity loss (yes/no) was formed so that those who scored a value 0–9 in either of the two questions were classified as 'reporting productivity loss', and were compared to those who scored 10 in both questions. The magnitude of productivity loss (i.e., how much productivity was reduced) was calculated using the formula [1 – (quality/10) x (quantity/10)] x 100 %, modified from an earlier study (Hoeijenbos et al. 2005).

The subject was asked to rate the intensity of pain caused by UED on a scale from 0 to 10 (0 corresponding to "no pain" and 10 to "the worst possible pain") and pain interference with work, leisure time and sleep during the last seven days (from 0, "no interference at all", to 10, "the worst possible interference"). Sick leaves due to UED during the preceding 12 months were also inquired.

For the assessment of physical exposures at work, the OH physician interviewed the subject about the frequency of lifting loads weighing 5 kg or more; working with hand(s) above the shoulder level; and whether work tasks required frequent or sustained elevations of the arms. Working at a keyboard, prolonged forceful gripping, as well as pinch grip that either required forceful exertion or deviated wrist posture, were also inquired. Each factor was dichotomized using a cut-off of being exposed for 10 % of the work time during the workday.

Job strain was measured with the Job Content Questionnaire (Karasek et al. 1998). Smoking habits and leisure physical activity were inquired, and waist circumference was measured. Fear-avoidance beliefs were assessed using four items adapted from Waddell et al: "Physical activity makes my symptoms worse", "If my symptoms become worse, it means that I should stop what I was doing", "My pain is caused by work", and "I should not continue in my present job because of the symptoms" (Waddell et al. 1993; Estlander 2003).

6.2.3. Randomised controlled trials (Studies IV–V)

In study IV, the effectiveness of a workplace related intervention was studied using self-assessed productivity loss caused by UED as the main outcome. Information from study III served as baseline for the intervention, and the follow-up time was 12 weeks. Randomization into intervention and control groups was performed by the physician using tables of random numbers in three blocks (symptoms in wrist or forearm, elbow, or shoulder) and sealed envelopes. Based on power calculations, the target was to include 500 subjects in the study.

All subjects received the best current practice treatment (Varonen et al. 2007). The supervisors of the employees in the intervention group were contacted by phone by the physician to discuss potential accommodations at work. A few days after the clinical examination, an occupational physiotherapist visited the workplace. The aim of the worksite visit was to investigate ergonomic improvements that were considered beneficial for the recovery from the UED. The assessment included the physical work environment and the available tools or instruments, working postures, force requirements, work pace and breaks during work, as well as assessing the employee's possibilities to continue working. The proposals were discussed together with the employee and the supervisor who then made the final decision on the technical and administrative changes required to modify the work load.

The primary outcome measure was self-assessed productivity loss at work, as described in study III, measured at baseline, eight weeks and 12 weeks. In addition, the employees were inquired about the numbers of sick leave episodes due to any reason, and exclusively due to UED, during follow-up. The contents of the ergonomic interventions as reported by the physiotherapists during the workplace visits were also analysed.

The protocol of the second intervention study (study V) aims to assess the health effects of early part-time sick leave compared to conventional full-day sick leave. This protocol was designed based on the results of previously published studies on part-time sick leave (Kausto et al. 2008). The feasibility of the study design was discussed and modified with the representatives from the participating workplaces. Prior to the RCT, the protocol and the questionnaires were tested by one OHS unit in a pilot study based on voluntary participation of some employees in part-time sick leave. The final protocol was approved by the Coordinating Ethics Committee of Hospital District of Helsinki and Uusimaa.

This study V is on-going and therefore only the protocol is described in this thesis. In those patients with MSD seeking medical advice and fulfilling inclusion criteria, the OH physician invites the subjects into the study. The physician also informs the employee about the study and its aims, and if the employee agrees to participate, informed consent will be signed. This includes a permission to contact the supervisor, preferably during the patient's visit, in order to investigate whether work-related arrangements for part-time sick leave would be feasible, in the case that the employee is allocated to the intervention group. If the supervisor disagrees, then the worker will be excluded from the trial.

Once the agreements from the employee and the supervisor are obtained and before the randomisation, the physician determines the length of the sickness absence based on symptoms, clinical findings and background information. Subsequently, if the employee is allocated to part-time sick leave (intervention group), daily work load will be reduced by limiting the working time. Also, if necessary, remaining work tasks could be modified so that working is possible despite the presence of symptoms. In the control group, work load is eliminated by full-time sick leave. Both groups receive appropriate medical advice, and the need for medical treatments and a control visit are determined as usual.

6.3. Statistical analyses

6.3.1. Systematic review (Study I)

For the eligible studies that did not adjust for cluster randomisation, the design effect was calculated based on a fairly large assumed intracluster correlation of 0.10 (Campbell et al. 2001), following the methods defined in the Cochrane handbook (Deeks et al. 2005). The length of follow-up was categorized as short term (less than three months), intermediate (three to 12 months) or long term (more than 12 months). This classification is used for the description of the results.

For comparisons with dichotomous outcomes and sufficient data, the adjusted results of each trial were plotted as odds ratios (ORs). For comparisons with similar interventions but with both dichotomous and continuous outcome measurements, an effect size was calculated based on the logarithm of the OR for studies with dichotomous outcomes, and on the standardised mean difference for studies with continuous outcomes (Chinn 2000). The ORs of studies were combined that compared similar interventions and having measured back pain or back injury with a similar follow-up time. The effect sizes of studies with similar interventions that measured sickness absence rate or disability score at a similar follow-up time were combined by using the generic inverse variance method using the software as implemented in RevMan 4.2. for both meta-analyses.

6.3.2. Surveys (Study II–III)

In study II, factors associated with self-assessed work ability were studied in a multinomial logistic regression model (SPSS® Programme, version

12.0.1). The outcome variable was work ability in three levels ('able', 'partially able', and 'unable'). The explanatory variables were gender, age group, occupational status, OH centre, duration of symptoms, disease group, work-relatedness of disease and potential of work-related interventions.

Logistic regression models were used in study III to study the determinants of productivity loss. The results are presented with ORs with 95 % confidence intervals (95 % CI). Multivariable models included age, gender and those variables associated with productivity loss with a P-value < 0.20 in the gender-adjusted or age- and gender-adjusted models. Due to the collinearity of pain intensity and pain interference, no mutual adjustment was performed, whereas their effects were assessed in separate models adjusted for the other covariates. In addition to the separate effects of pain intensity, excessive job strain and physical load factors on productivity loss, their joint effects were also estimated, since it was hypothesized that these variables could act synergistically. Multiplicative interactions were also tested by including interaction products in the multivariable model. The possible effect modification by age was also investigated with stratified analyses using median age (45 years) as cut-off. STATA, version 8.2, software was used for the analyses.

6.3.3. Randomised controlled trials (Studies IV–V)

Data in study IV were analysed according to the intention-to-treat principle. Missing data on productivity at 12 weeks (7 in the control group and 8 in the intervention group) were substituted with the value at 8 weeks. Three outcomes were used: proportion of productivity loss (dichotomized), magnitude of productivity loss (continuous) and change in magnitude of productivity loss from baseline (continuous). At 8 and 12 weeks, the test for differences (two-tailed, P<0.05) was chi-squared test for the proportion and two-sample t-test for magnitude and change. Generalized estimating equation (GEE) was applied to analyse repeated measures data (Hanley et al. 2003). The link function was specified as "logit" for the dichotomized outcome. In addition to the allocation group and follow-up time, age (continuous), gender, exposure to physical work load factors (lifting loads ≥5 kg, arm elevations at or above shoulder level, or forceful or pinch grip) and fear-avoidance beliefs (continuous) were included as covariates in the models.

It was also intended to identify some modifiable subgroup variables that could affect the effectiveness of the intervention. Subgroup analyses were performed by using the following variables: job demand, job control, fear–avoidance beliefs (all dichotomized using the median), exposure to physical work load factors, and prior sickness absence due to UED. To take into account the difference in the magnitude of productivity loss between the intervention and control group at baseline, the changes in productivity loss during the follow-up were utilized in the sub-group analyses. STATA, version 10, software (StataCorp LP, College Station, TX, USA) was used for the analyses.

In study V, a survival analysis will be used to study the time to RTW in the intervention and control group. The amount of sick leave days will be analysed at 12 and 24 months, and the associations between the outcomes and background variables will be analysed using general linear models. In addition, the change in symptoms and disability indices will be studied at various time points using general linear models for repeated measurements.

The costs and benefits to the employee, employer and society will be estimated in both study groups. Costs due to lost working time will be analysed separately taking into account the compensation from the Social Insurance Institution to the employer during full- or part-time sick leave. Data on costs of the used health services, medications, and medical aids (due to the main health problem) will also be collected. In addition, the analysis will include the compensation of the lost work input using stand-ins (salary, training time) or overtime (performed by the colleagues of the study subjects), as well as the time the supervisor used to accommodate the new work arrangements. All analyses will be made based on an intention-to-treat principle.

The non-monetary benefits will be studied based on self-assessed productivity at work (Brouwer et al. 1999), as well as the reduction of pain and disability measured on a scale from 0 to 10. If there is a difference between the groups in the outcome measurements, a cost-effectiveness analysis will be undertaken dividing the costs by the units of difference in the outcome. If there is no significant difference between the study groups in any of the health related outcomes, the analysis of total costs in both groups will be applied in drawing the final conclusions.

7. RESULTS

7.1. Training and lifting devices for preventing back pain (Study I)

Altogether, 3547 titles were found as the result of the primary search strategy in nine databases. The sensitive search strategy provided 47 additional titles. Another 17 references were found in a manual search. Thus from the total of 3611 articles, 101 were selected for closer evaluation. Eighty-nine articles did not meet the inclusion criteria. Two articles (Fanello et al. 1999; Fanello et al. 2002) reported on the same study. Consequently, 11 studies were included in the review.

Four of the included studies were cluster randomised (Daltroy et al. 1997; van Poppel et al. 1998; Yassi et al. 2001; Kraus et al. 2002), two were individually randomised (Reddell et al. 1992; Müller et al. 2001), and five were cohort studies (Dehlin et al. 1981; Feldstein et al. 1993; Best 1997; Fanello et al. 1999; Hartvigsen et al. 2005). Two (Daltroy et al. 1997; van Poppel et al. 1998) randomised trials and all cohort studies were labelled as high quality. The characteristics of the included studies are described in table 6.

In three randomised trials (Müller et al. 2001; Yassi et al. 2001; Kraus et al. 2002) and all five cohort studies, manual handling was related to patient care. Postal workers were studied in one (Daltroy et al. 1997), and baggage handlers in two (Reddell et al. 1992; van Poppel et al. 1998) trials. In all of the jobs studied, the participants were exerting sufficient strain on the back leaving ample room for alleviation by effective interventions. The number of participants in randomised trials varied from 51 to 12,772, and the follow-up time from 6 months to 5.5 years. The cohort studies included 45 to 345 participants, and the follow-up times varied from 8 weeks to 2 years.

TABLE 6. Characteristics of included studies

	Design, participants	Intervention *v* control	Length of follow-up	Outcomes	Methodological quality
Daltroy 1997, USA	Cluster randomised 3597 postal workers	Training and ergonomic site visit *v* standard training (video)	5.5 years	Back injury rate (disabling and non-disabling) per 1000 worker years of exposure	High (6 *v* 11)
Kraus 2002, USA	Cluster randomised, 12 772 home care workers	Safety meeting *v* back belt, no intervention	28 months	Back injury rate per 100 full time equivalents	Low (5 *v* 11)
van Poppel 1998, Netherlands	Cluster randomised, 312 cargo handlers	Training *v* lumbar support, lumbar support and training, no intervention	6 months	No of subjects with LBP; No of subjects with sick leave and No of days per month with LBP; No of days per month of sick leave because of LBP	High (8 *v* 11)
Yassi 2001, Canada	Cluster randomised, 346 nurses	"No strenuous lifting" *v* "safe lifting" programme, "usual practice"	1 year	Experienced work related LBP and its intensity during past week; Oswestry disability questionnaire; rate of back or trunk related injuries	Low (4 *v* 11)
Müller 2001, Germany	Randomised, 51 nurses	Training *v* exercise in space curl	12 months	Frequency of LBP	Low (3 *v* 11)
Reddel 1992, USA	Randomised, 642 fleet service clerks	Training *v* back belt, back belt and training, no intervention	8 months	Back injury rate (no raw data available)	Low (2 *v* 11)
Fanello 1999, France	Cohort study, 272 nurses and cleaners	Training and feedback at work *v* no intervention	2 years	Prevalence of LBP	High (8 *v* 12)
Best 1997, Australia	Cohort study, 55 nurses	Training *v* in-house orientation	12 months	Self reported LBP during past week and past year	High (8 *v* 12)
Dehlin 1981, Sweden	Cohort study, 45 nurses	Training *v* physical exercise, no intervention	8 weeks	Frequency of low back symptoms	High (7 *v* 12)
Feldstein 1993, USA	Cohort study, 55 nurses	Training, practical feedback *v* no intervention	1 month	"Composite back pain"	High (7 *v* 12)
Hartvigsen 2005, Denmark	Cohort study, 345 nurses	Training *v* one instructional meeting	2 years	No of episodes and No of days with LBP during past year	High (9 *v* 12)

The training interventions focused on lifting techniques, and their duration varied from a single session to once a week training for a period of two years (Table 7). In three studies, the training was supported by follow-up and feedback at the workplace. The advocated lifting techniques were not described in detail. The involvement of supervisors was clearly indicated in three studies, and the encouragement to use available lifting aids was stated in five studies. A professional instructor was used in most studies.

Compliance with the instructions and with the use of assistive devices was monitored in five studies (Feldstein et al. 1993; Best 1997; van Poppel et al. 1998; Yassi et al. 2001; Hartvigsen et al. 2005). Three studies reported positive changes in lifting techniques in three studies and there were marginal or no changes in two studies. In addition, one study (Daltroy et al. 1993) has reported separately that the intervention resulted in increased knowledge but not in any significant improvement of manual handling behaviour.

Comparison between groups receiving training or no intervention in two randomised trials (van Poppel et al. 1998; Yassi et al. 2001) indicated that there was no difference in the amount of back pain (OR 0.99, 95 % CI 0.54 to 1.81) or related disability (effect size 0.04, 95 % CI –0.50 to 0.58) at intermediate follow-up. The same result was obtained in another randomised trial (Reddell et al. 1992), which was not included in the meta-analysis because insufficient data were reported. One randomised trial (Kraus et al. 2002) showed no effect in back pain at long-term follow-up (OR 1.07, 95 % CI 0.06 to 17.96). The results of three cohort studies supported those of the randomised studies at short-term (Dehlin et al. 1981; Feldstein et al. 1993) and long-term follow-up (Fanello et al. 1999).

Training compared to minor advice (video) in one randomised trial (Daltroy et al. 1997) did not show an effect on back pain at long-term follow-up (OR 1.08, 95 % CI 0.56 to 2.08). This conclusion was supported by the results of two cohort studies (Best 1997; Hartvigsen et al. 2005) using in-house orientation or less extensive training as the control interventions.

Comparison of training and lumbar support use did not yield a significant difference in back pain at intermediate follow-up according to one randomised trial (Reddell et al. 1992). Another randomised trial (Kraus et al. 2002) came to a similar conclusion with respect to long-term follow-up (OR 1.04, 95 % CI 0.06 to 17.38).

TABLE 7. Details of interventions in studies aimed at preventing back injury and pain caused by lifting and handling patients or heavy objects

Study	No and duration of sessions	Time span of training	Training as described in article	Training methods*	Management commitment	Use of assistive devices	Ergonomic intervention(s) included	Reinforcement included
Daltroy	2 x 1.5 hours	1 week	Proper lifting and carrying techniques	B	Yes	No	Yes	Yes
Kraus	Unclear	Unclear	Safety practices when handling patients	Unclear	Not mentioned	No	No	No
van Poppel	3 x 1.5-2 hours	12 weeks	Anatomy and lifting techniques	B	Not mentioned	No	No	No
Yassi	1 x 3 hours	Single training	"Safe lifting" or "no strenuous lifting." Handling techniques coupled with available equipment	B	Not mentioned	Encouraged	No	No
Müller	Unclear	Unclear	Unclear	Unclear	Not mentioned	Unclear	Unclear	Unclear
Reddel	1 x 1 hour	Single training	Balancing load, pivoting instead of twisting, getting close to load, squat lift, squaring load, maintaining three point contact	B	Not mentioned	No	No	No
Best	32 hours (in total)	Unclear	Semisquat posture and weight transfer techniques such as bracing, pivoting, lunging, and counterbalancing load	Unclear	Not mentioned	No	No	No
Dehlin	8 x 45 min	8 weeks	Short lever arms during lifting, minimising weight of burden by lifting together	A	Not mentioned	Encouraged	No	No
Fanello	6 (length unclear)	6 days	Method revised by Paul Dotte as applied also by Best et al	Unclear	Not mentioned	Encouraged	No	Yes
Feldstein	1 x 2 + 8 hours	2 weeks	Specific technique for patient transfer	B	Yes	Encouraged	No	No
Hartvigsen	104 x 1 hour + 4 x 2 hours	2 years	"Bobath principle"	B	Yes	Encouraged	No	Yes

*A=least engaging (lectures, pamphlets, videos); B=moderately engaging (programmed instructions, feedback interventions); C=most engaging (training in behavioural modelling, hands-on training).

Training and physical exercise were compared in one randomised trial (Müller et al. 2001) and no difference in back pain was found at the intermediate follow-up. The results of one cohort study (Dehlin et al. 1981) provided support to the conclusion made at the short-term follow-up.

A group receiving training and assistive devices was compared to the groups receiving training only or no intervention at all in one randomised trial (Yassi et al. 2001). No difference in back pain was shown in intermediate follow-up of either comparison (OR 0.42, 95 % CI 0.04 to 4.99). In addition, there was no difference in relation to back related disability.

7.2. Factors associated with self-assessed work ability (Study II)

A total of 971 consecutive patients were enrolled by 12 physicians. Questionnaires completed by both the patient and the physician were available for 950 visits (98 %). The statistical analyses focused on 723 (76 %) visits, where the reason for the contact given by the patient and the diagnosis made by the physician were in the same major disease group.

MSD (39 %) was the most common reason for the visit, followed by respiratory (17 %), cardiovascular (11 %), dermatological (9 %), mental (7 %), and "other" disorders (16 %). In most cases the duration of the symptoms was longer than six months. Respiratory symptoms had lasted for less than two weeks in half of the cases.

TABLE 8. Self-assessed ability to work by the main diagnosis of the visit

Disease group	N	Self-assessed ability to work			
		Able (%)	Partially able (%)	Unable (%)	Cannot say (%)
Musculoskeletal	283	51	28	16	5
Respiratory	125	58	24	10	8
Cardiovascular	83	80	16	4	1
Dermatological	67	96	4	0	0
Mental	47	40	30	23	6
Other	118	74	19	6	2
TOTAL	723	63	22	11	4

Sixty-three percent of the patients reported being able to work despite their health problem (table 8). In total, partial work ability was reported by 22 % and full disability by 11 % of the patients. Those with mental disorders reported full or partial disability most often (in 53 % of the cases), followed by those with MSD (44 %).

The patients regarded mental (85 %) and MSD (74 %) most often as being at least possibly work-related (table 9). The physicians were more cautious in assessing work-relatedness in every disease category. In general, they regarded the reason as work-related in 13 % and possibly work-related in 21% of the visits. The disorders most often regarded as work-related by the physicians were mental problems (26 %) and MSD (22 %).

TABLE 9. Work-relatedness assessed by patients and physicians by the main diagnosis of the visit

	N	Not work-related (%)	Possibly work-related (%)	Work-related (%)	Cannot say (%)
Musculoskeletal	283				
- Patients		18	41	33	8
- Physicians		42	34	22	2
Respiratory	125				
- Patients		51	32	6	10
- Physicians		86	8	4	2
Cardiovascular	83				
- Patients		31	51	8	10
- Physicians		71	22	6	1
Dermatological	67				
- Patients		66	12	6	16
- Physicians		88	7	3	1
Mental	47				
- Patients		13	36	49	2
- Physicians		40	32	26	2
Other	118				
- Patients		49	24	9	18
- Physicians		85	6	6	3
TOTAL	723				
- Patients		34	35	20	11
- Physicians		64	21	13	2

Work-related interventions were considered as beneficial by the patients in one third of the cases, most frequently when the reason for the visit was a mental problem (56 %) or MSD (39 %).

In the multinomial logistic regression model, gender had no effect on self-assessed work ability (table 10), but older age markedly increased the risk of disability. Blue collar employees ran a higher risk of both partial and full disability compared to upper white collar employees. A short duration of the symptoms was associated with both partial and full disability to work.

TABLE 10. Odds ratios (OR) and 95 % confidence intervals (CI) for the adjusted effects of the patient and disease characteristics on self-assessed ability to work

	Self-assessed ability to work			
	Partially able[a]		Unable[a]	
Predictor	**OR**	**95% CI**	**OR**	**95 % CI**
Gender (male vs. female)	1.1	0.6–2.0	0.9	0.4–2.2
Age (reference category '35 years or less')				
– 35–44 years	1.2	0.6–2.5	4.8	1.2–18.6
– 45–54 years	1.1	0.5–2.2	4.3	1.1–17.1
– 55 years or older	1.6	0.7–4.0	8.9	1.9–41.4
Occupational group (reference category 'upper white collar')				
– lower white collar	1.8	0.8–4.3	2.4	0.6–9.2
– blue collar	6.5	2.6–16.4	8.1	2.0–33.2
Duration of the symptoms before the visit (reference category 'more than 6 months')				
– 2–6 months	1.0	0.4–2.2	1.5	0.5–4.3
– 2 weeks to 2 months	2.0	0.8–4.5	0.6	0.1–2.6
– less than 2 weeks	3.4	1.6–7.5	3.7	1.3–10.7
Disease group ('other disease incl. skin diseases' as reference category)				
– musculoskeletal	2.5	1.2–5.1	7.7	2.2–26.6
– respiratory	2.4	1.1–5.6	2.7	0.7–10.6
– cardiovascular	1.7	0.6–4.5	2.0	0.3–14.1
– mental	2.1	0.7–6.4	17.5	3.5–86.3
Assessment of work-relatedness				
– 'possible' vs. 'no'	2.9	1.4–6.0	1.3	0.4–3.7
– 'yes' vs. 'no'	5.2	2.1–12.8	12.8	3.9–41.9
Potential of work-related interventions				
– 'possible' vs. 'no'	1.6	0.8–3.0	0.5	0.2–1.2
– 'yes' vs. 'no'	2.0	0.9–4.6	0.2	0.1–0.8
OH centre (A vs. B)	1.1	0.5–2.2	3.4	1.2–9.7

[a] reference category patients with self-assessed normal ability to work

MSD increased the risks of both partial and full disability. The highest risk of full disability was observed for mental disorders. The risk of partial work ability was increased for respiratory diseases. Self-assessed work-relatedness of the disease increased the risks of both partial and full disability to work, whereas the risk of full disability was significantly reduced, if the patient considered work-related interventions as being beneficial.

The OH centre had a statistically significant effect on disability, but eliminating this variable from the model did not affect the risk estimates of the other variables.

7.3. Self-assessed productivity loss caused by upper extremity disorders (Study III)

The recruitment was ended as planned even though the target of 500 study subjects was not achieved. This was due to the smaller than expected number of subjects fulfilling inclusion criteria, as well as the relatively slow recruiting process in general. Altogether 222 subjects participated in the study. Forty-five subjects were excluded because they did not meet the criteria for eligibility, leaving 177 subjects to the study. After exclusion of a further nine subjects with missing information on productivity, 168 subjects (95 %) were included in the analyses. The most common occupations were nurses and other health care workers (64 %), secretaries and other clerical workers (25 %), and warehouse workers (8 %). The majority (87 %) were female, and the average age was 45 years.

The most prevalent UED were epicondylitis (29 %), specific shoulder disorder (28 %) and non-specific upper limb pain (26 %). The subjects reported pain intensity and pain interference with work to be on average 4.7 (max 10) and 4.8, respectively. Pain interference with sleep was somewhat lower (3.3). Sickness absence due to UED during the last 12 months was reported by 37 % of the subjects. Working at a keyboard and lifting loads were the most common physical work load factors. High job strain was reported by 27 % of the subjects. Every seventh subject had elevated scores on fear-avoidance beliefs, and every second perceived their disorder as being work-related.

More than half of the subjects (56 % of women, 59 % of men) reported that the UED had decreased their productivity. The average production loss was 34 % during the previous work day, corresponding to an average of 19 % loss of productivity among all study subjects.

Age and gender were not associated with productivity loss (table 11), and neither were smoking habits, waist circumference or physical activity. Subjects in the diagnostic category "other", mainly with median or ulnar nerve entrapment, were at the highest risk of productivity loss.

TABLE 11. Odds ratios (OR) of productivity loss adjusted for gender and age* or gender alone according to background characteristics**

Characteristic	All*		20-45 yrs**			46-64 yrs**		
	OR	95 % CI	n	OR	95 % CI	n	OR	95 % CI
Gender								
Female (reference category)			67			79		
Male	1.2	0.4-3.0	13	1.5	0.4-4.9	9	0.9	0.2-3.6
Age (continuous)	1.00	0.97-1.04		-			-	
Diagnosis								
Epicondylitis (reference category)			25			24		
Shoulder disorder	1.5	0.6-3.5	21	1.4	0.4-4.6	26	1.6	0.5 -4.9
Wrist tenosynovitis	1.7	0.5-5.3	8	4.2	0.6-26.3	9	0.8	0.2-3.7
Nonspecific pain	1.9	0.8-4.4	23	2.3	0.7-7.4	20	1.5	0.4-5.0
Other	6.2	1.2-31.4	3			9	3.5	0.6-20.4
Pain intensity								
1st tertile (reference category)			26			27		
2nd tertile	3.7	1.6-8.2	28	3.3	1.1-10.3	27	4.0	1.3-12.6
3rd tertile	3.0	1.4-6.6	26	3.1	0.99-9.6	30	2.9	0.98-8.6
Pain interference with work								
1st tertile (reference category)			23			31		
2nd tertile	2.7	1.2-5.9	24	1.9	0.5-6.4	30	3.6	1.2-10.5
3rd tertile	6.2	2.6-14.4	32	6.7	2.0-22.3	23	5.1	1.5-16.9
Pain interference with leisure time								
1st tertile (reference category)			21			31		
2nd tertile	1.7	0.8-3.7	32	1.4	0.4-4.2	25	2.2	0.7-6.5
3rd tertile	1.8	0.8-3.8	27	1.4	0.4-4.3	28	2.2	0.7-6.2
Pain interference with sleep								
1st tertile (reference category)			26			26		
2nd tertile	1.6	0.7-3.4	31	0.7	0.2-2.2	25	4.2	1.3-13.5
3rd tertile	2.5	1.1-5.5	23	1.0	0.3-3.2	33	6.0	1.9-18.6

Table 11. continues...

Characteristic	All*		20-45 yrs**			46-64 yrs**		
	OR	95 % CI	n	OR	95 % CI	n	OR	95 % CI
Physical exposures at work								
Lifting loads, ≥5 kg								
No (reference category)			52			68		
Yes	2.1	0.99-4.5	28	1.9	0.7-5.1	18	2.3	0.7-7.2
Arm elevations or above shoulder								
No (reference category)			67			77		
Yes	1.9	0.7-4.9	13	2.1	0.5-7.6	9	1.6	0.3-6.8
Forceful or pinch grip								
No (reference category)			69			80		
Yes	1.5	0.5-4.4	11	1.5	0.4-5.8	6	1.6	0.2-9.1
Working at a keyboard								
No (reference category)			39			45		
Yes	0.7	0.3-1.4	41	1.4	0.5-3.5	41	0.4	0.2 -1.1
Previous sickness absence (past 12 months)								
No (reference category)			46			60		
Yes	2.2	1.1-4.3	34	3.4	1.3-8.7	28	1.5	0.5-3.7
High job strain								
No (reference category)			50			64		
Yes	1.3	0.6-2.8	23	3.9	1.3-11.8	20	0.5	0.2-1.4
Elevated score on fear-avoidance beliefs								
No (reference category)			69			75		
Yes	3.5	1.2-9.9	11	4.6	0.9-23.1	13	2.8	0.7-10.9

Pain intensity, pain interference with work, and fear-avoidance beliefs were associated with productivity loss. Pain interference with sleep was also associated with productivity loss, but only in the older age group.

With respect to the physical exposures at work, only lifting at work showed an association with productivity loss. High job strain and prior sick leave were associated with productivity loss, but only among the younger subjects. If the younger subjects were convinced about work-relatedness of the disorder (response in the third tertile), the prevalence of productivity loss was increased (OR 4.5, 95 % CI 1.2–16.6). No similar association was found in the older subjects.

In a mutually adjusted model with gender, age, pain intensity, physical exposures at work, previous sickness absence, high job strain and fear-avoidance beliefs, only pain intensity and fear-avoidance beliefs showed associations with productivity loss. Pain interference with work was also associated with productivity loss with an OR of 2.5 (95 % CI 1.1–5.7) for the 2nd tertile and 5.7 (95 % CI 2.2–14.3) for the 3rd tertile, when it was included in the model instead of pain intensity. In the younger workers only high job strain, and in the older workers only pain interference with sleep, remained statistically significant after adjustment for the other factors.

The separate and joint effects of physical work load factors, pain intensity and job strain on productivity loss were also studied. In general in the younger subjects, a combination of any two of these factors was associated with a higher degree of productivity loss than the presence of only one factor. High job strain seemed to contribute most to the productivity loss and physical exposures the least. When the interaction products were included in the logistic regression models, only the inclusion of the interaction between physical loads and pain intensity improved the goodness-of-fit of the model.

7.4. Effectiveness of an ergonomic intervention on productivity loss (Study IV)

A total of 177 participants were randomised to the intervention (91 subjects) and control group (86 subjects). During the 12 week follow-up, the participation rate was 87 % in the intervention group and 88 % in the control group.

Most participants were female in both groups. There was no major difference in the distribution of age and life-style related risk factors between the intervention and control group. Pain intensity, pain interference with work, leisure time and sleep, as well as the prevalence of previous sick leaves and high job strain were also similar in the two groups. Both groups had similar mean scores for the fear-avoidance beliefs; however, elevated scores on fear-avoidance beliefs were found almost twice as often in the intervention group as in the control group (18 % versus 11 %). Specific shoulder disorders were more prevalent (35 % versus 21 %)

and exposure to lifting at work was more frequent (38 % versus 18 %) in the control group than in the intervention group. All cases of "other UED" belonged to the intervention group only.

From a total of 531 potential observations, 465 (88 %) were included in the analyses. Nine observations at baseline, 36 at 8 weeks and 21 at 12 weeks were excluded. In comparison with those included in the analyses, the excluded subjects were younger (mean age 42 versus 46 years), they had higher scores on pain intensity (5.4 versus 4.7), and they had been more often on sick leave prior to the enrolment (57 % versus 36 %). In addition, the excluded employees were twice as often exposed to lifting at work than the employees included in the analyses (46 % versus 28 %).

With respect to the 66 excluded observations, 30 (46 %) were in the control group and 36 (55 %) in the intervention group. Those excluded from to the intervention group more commonly reported exposure to lifting > 5 kg (53 % versus 34 %), and had a higher level of pain intensity (mean 5.6 versus 5.1), pain interference with work (mean 5.5 versus 4.7), pain interference with leisure time (mean 5.4 versus 4.2), and pain interference with sleep (mean 4.2 versus 2.4) at baseline in comparison to the excluded subjects in the control group. On the other hand, excluded subjects in the intervention group less frequently reported productivity loss (among 39 subjects, magnitude 13 % versus 30 %) and elevated score on fear-avoidance beliefs (0 versus 18.5 %) than those excluded in the control group. No differences were found with respect to age, job strain and sickness absence prior to the enrolment.

Eight weeks after the enrolment, almost all subjects (92 %) in the intervention group but only 8 % in the control group reported that an occupational physiotherapist had visited their workplace. The ergonomic assessment was most often made together with the employee alone, and the supervisor had participated in 17 % of the assessments. A total of 412 implemented or planned measures had been identified. The majority (60 %) were related to guiding the employee in self care, working posture, use of tools and instruments, using both hands in work tasks, and reorganising how the work was done. The recommendations to be implemented in the imminent future (25 % of the measures) included purchasing a new aid or tool, and reorganising work or its environment. The modifications at work made during the visit

(16 % of the measures) included changes to the keyboard and monitor, structures of the workplace (including arm rests), and adjustments to the table and the chair.

Productivity loss at baseline was reported by 53.8 % in the intervention group and 57.9 % in the control group (figure 5). At 8 weeks, both the proportion and magnitude of productivity loss were lower in the intervention than in the control group. However, the differences were not statistically significant. At 12 weeks, the proportion and magnitude of productivity loss were statistically significantly lower in the intervention than in the control group (proportion 25 % versus 51 % and magnitude 7 % versus 18 %, respectively, P = 0.001 for both).

The analysis of repeated measures using GEE revealed statistically significant differences in the proportion and magnitude of productivity loss between the intervention and control group after adjustment for age, gender, physical work load factors, fear-avoidance beliefs and follow-

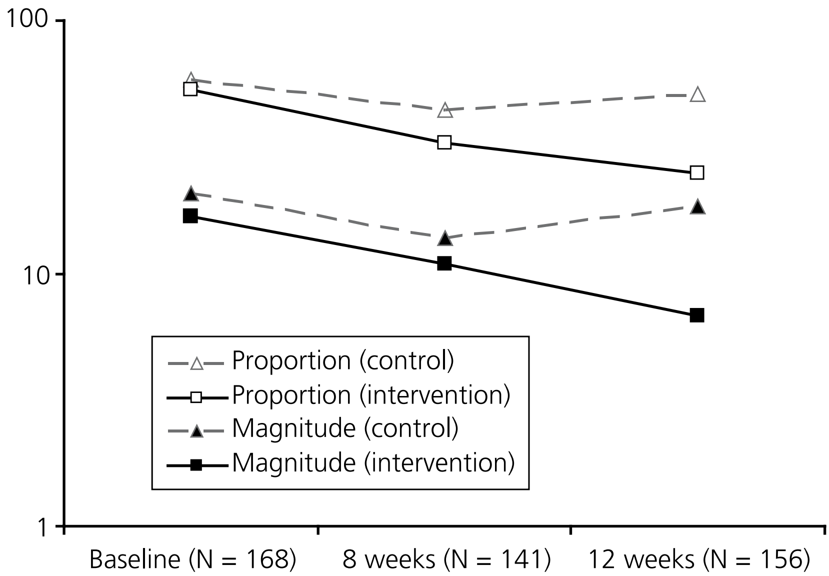

FIGURE 5. Proportion and magnitude of productivity loss (on a logarithmic scale) at baseline, eight and twelve weeks after the intervention in the control and intervention groups.

up time. There was an interaction between intervention and time, the proportion (P = 0.009) and magnitude (P = 0.033) of productivity loss being lower in the intervention group than in the control group only at 12 weeks.

In the employees without any productivity loss at baseline, 15.6 % in the intervention group had developed productivity loss at 8 weeks, whereas this proportion was almost two-fold in the control group. The magnitude of productivity loss was 3.7 % and 8.1 %, respectively. At 12 weeks there was almost a 4-fold difference in the proportion and an 8-fold difference in the magnitude between the intervention and control group. With GEE analyses, the differences were noted to be statistically significant.

Among employees with productivity loss of 10–20 % at baseline, the reduction in magnitude of productivity loss was more prominent in the intervention group than occurred in the control group at 8 weeks and 12 weeks. At 12 weeks also the proportion of productivity loss was lower in the intervention than in the control group. If the baseline productivity loss was higher than 20 %, there were no significant differences between the study groups in terms of productivity loss during the follow-up.

The improvement of productivity at 12 weeks was significantly better in the intervention group than in the control group in the subsample of subjects with no working at a keyboard at work but exposure to other physical work load factors (P = 0.033), with low job demands (P = 0.036), among those with no sickness absence due to UED before the study (P = 0.043), as well as those with low fear avoidance (P = 0.033). The improvement did not differ between intervention and control groups in those with low or high job control.

Among those who had been on sick leave for any reason during four weeks preceding the follow-up at 12 weeks, there was no difference in the change of productivity between the intervention and control groups. In contrast, those individuals in the intervention group who had not been on sick leave, had a higher improvement in productivity at 12 weeks compared with the control group (6.5 versus 2.4 %, P = 0.033).

There was no difference between the control and intervention group in pain intensity at 12 weeks (mean 2.6 versus 2.9) or in pain interference with work (mean 2.4 versus 2.5).

7.5. Early part-time sick leave in musculoskeletal disorders (Study V)

During the pilot study there were some challenges related to finding eligible individuals at the OHS, an extra work load on the OH physicians in implementing the intervention to the employees and the supervisors, as well as the many practical issues related to administrative questions at work during part-time sick leave. However, the arrangements at the workplace were usually considered as being feasible to implement and the attitude of the supervisors and co-workers was mostly positive and supportive. This provided an impetus to initiate the actual RCT at the beginning of 2008. The recruitment period of this study ended in December 2009, but the follow-up will not end until December 2010, and the reporting of the results will start in 2011.

8. DISCUSSION

8.1. Main findings

8.1.1. Primary prevention of low back pain and related disability

We found no evidence that training with or without lifting equipment would be effective in the prevention of back pain or consequent disability (study question No I). The reason may be that either the advocated techniques did not reduce the risk of back injury, or training did not lead to an adequate change in lifting and handling techniques. There were no differences in the results between the analyses from studies with different designs or with different types of lifting and handling. Two randomised controlled trials published later lent support to the present results (Jensen et al. 2006; Lavender et al. 2007).

One explanation for the lack of any effect could be that the intervention was not appropriate. As training methods become more engaging, workers acquire more knowledge and the number of injuries declines (Burke et al. 2006). Accordingly, the training methods were classified based on learners' participation, but the review failed to detect a more positive outcome for studies that involved more intense training methods.

The risk of back pain might be related not to incorrect handling techniques but to other work-related factors inherent in the populations studied (such as non-neutral, bent, or rotated trunk postures without lifting or handling, or psychosocial strain). It was not possible to test this hypothesis, however, because none of the studies described the context of the intervention in sufficient detail to enable further analysis. It has also been argued that the size of the effect of work-related physical demands is less than that of other individual, non-occupational and unidentified factors (Waddell et al. 2001).

One reason why training in correct lifting techniques and assistive devices did not reduce LBP or related disability is most likely the complexity of the impact of physical and psychosocial risk factors at work. As proposed by the model of Cox et al (Figure 3), even physical load factors which have an influence on the worker's health are mediated through cognitive and psycho-physiological pathways. Thus, the reduction of only physical load at work does not, therefore, automatically result in the reduction of musculoskeletal symptoms and disability. The need for influencing simultaneously on both physical and psychosocial exposure has been seen as the more effective approach to the reduction of disability (Cote et al. 2008), preferably in collaboration with the workers (Hignett et al. 2005).

8.1.2. Factors associated with perceived disability

The results of study II indicated that perceived partial disability is common, especially in mental problems and MSD. These two disorders are also most often regarded as work-related by the patients and their physicians. MSD and mental disorders as such, as well as perceived work-relatedness of the health problem, are strongly associated with impairment in self-assessed work ability (study question No II).

According to the patients, 74 % of MSD cases were definitely or possibly caused or made worse by work, whereas OH physicians found definite work-relatedness in only 22 % and a possible connection in 34 % of the cases. These figures are comparable to the results of a Norwegian study, where pain in the neck, shoulder and arm was considered as being work-related by 78–80 % of the subjects (Mehlum et al. 2009). In that study, the physicians used specific criteria for work-relatedness, and they assessed work-relatedness as "probably", "possibly" and "not work-related". These differences explain why in the present study the physicians' assessments were lower than the experts' assessments in the Norwegian study (56 % versus 65–72 %). Moreover, in the Norwegian study, the physician knew the study subject's assessment before making his/her own evaluation.

Another study has compared the assessments of work-relatedness made by patients on sick leave as compared with the assessment by their OH physicians (Giri et al. 2009). Once again, the patients more often believed that the illness has been caused by work than OH physicians (30 % versus 16 %), and that the illness was made worse by work (60 % versus 44 %). In addition to MSD and other illnesses, 37 % of the patients had a mental problem as the reason for absence, which may have influenced the patients' assessments of work-relatedness of their ailments.

This study showed that the patients' negative perceptions about their illness and work would be associated with impaired ability to work. This was a cross-sectional study and, therefore, it is not known if the patients were absent from work because of the illness after the consultation. However, later studies have found evidence that employees with negative perceptions about their illness are less likely to return to work than those with positive beliefs (Elfering et al. 2009; Giri et al. 2009)

This study revealed that the risk of perceived disability was lower if the patient found benefits in potential work-related interventions. In a previous study (Tellnes et al. 1990), a potential for prevention was found in 37 % of the health problems underlying sickness certificates. In this study, work-related interventions were initiated exactly as often as in another Finnish study, where 9 % of the visits to OH physicians included or led to work-related interventions (Räsänen et al. 1997). The reason for this figure being considerably lower than the prevalence of work-related diseases may be that work-related interventions have been initiated already during earlier visits to the OH physician.

Based on the results, partial ability of an employee to work can possibly be restored, maintained and promoted by actions directed at the individual, but it should also include modifying the work environment and organizing work according to the individual's capabilities. In addition, recognition of work-related diseases is important for the appropriate assessment of patient's ill-health and for the effectiveness of therapeutic interventions. Identifying work-relatedness has the potential also for more adequate prevention, not only concerning the individual patients but also their co-workers, and for less absenteeism from work.

8.1.3. Productivity loss as an indicator of disability

In study III, more than half of the subjects with clinically diagnosed UED reported that the disorder impaired their productivity in various physical as well as sedentary occupations (study question III). On average, workers with UED reported that one third of their regular productivity has been lost, which in a normal work day would correspond to 2.5 hours of active working time.

Our results are consistent with current knowledge, i.e., pain intensity, pain interference with work, and lifting at work are associated with self-reported productivity loss (Hagberg et al. 2007; Boström et al. 2008). No studies have so far reported about the role of fear-avoidance beliefs in productivity loss. Conceptually, fearful beliefs may contribute considerably to productivity loss since they serve as an adaptive reaction to pain with some work activities being avoided if they are anticipated to produce pain and feared since they can cause 'damage'. Beliefs that work deteriorates chronic LBP have been shown to increase the risk of both work loss and disability in daily activities (Waddell et al. 1993). In general, fear-avoidance beliefs are strong predictors of future disability (Iles et al. 2008). However, it seems that this is the first study to report fear-avoidance beliefs affecting productivity loss in non-chronic conditions.

Unlike the previous studies, no association was found between age and productivity loss (Collins et al. 2005; van den Heuvel et al. 2007; Alavinia et al. 2009). However, it was found that age modified the effects of other factors, particularly the combined effects of physical work, job strain and pain intensity, on productivity loss. The strongest determinants of productivity loss in younger workers were having two of the following factors; intensive pain, high job strain, and physical work. Older workers' productivity was not affected by the combination of these factors.

Similar results, indicating that the younger workers may be more susceptible to the effects of work, have been found for example in a prospective study on the predictors of low-back pain (Miranda et al. 2008), as well as in relation to sickness absence (Taimela et al. 2007). The age-modification in productivity loss may partly be explained by health-based selection in which workers with health problems are more likely to leave a job. Other possible explanations are younger employees' (or their supervisors') higher expectations for daily performance, as well as older workers' better skills to compensate for health-related productivity loss.

8.1.4. Secondary prevention of disability

The results of study IV show that an early ergonomic intervention in addition to medical care can help to reduce work–related productivity loss associated with UED compared to medical care only (study question IV). The fact that the difference between the control and intervention group was largest at 12 weeks after the enrolment, suggests that the result is based on actual impact of the intervention rather than on the subjects' satisfaction with the additional attention they had received from the OHS. Many of the new aids or tools recommended by the occupational physiotherapists were not purchased until later during the course of the study. This may further explain why the difference between the study groups was found only at 12 weeks.

One possible explanation for the improved productivity is that the intervention managed to modify the employees' adverse work styles, which has been shown to be a risk factor for upper extremity pain and functional limitations (Nicholas et al. 2005; Meijer et al. 2008). The contacts by the physician and the physiotherapist might also have promoted a better understanding of the nature and consequences of the disorder at the workplace. Consequently, the employee and the supervisor were able to adjust the work requirements to better meet the restrictions during recovery and then the physiotherapist's practical suggestions supported the implementation of these changes.

Although the intervention showed beneficial effects on productivity, no difference in pain intensity was found between the groups at 12 weeks. Therefore, pain relief does not explain the results. Since the difference in productivity at 12 weeks was seen also in the subgroup with no sickness absence during the follow-up, the results cannot also be due to the intervening impact of sickness absenteeism.

A substantial effect of the intervention was seen among those employees with no or only mild productivity loss at baseline. The other subgroup analyses showed that those with less fear-avoidance beliefs, more physical load factors at work, or low job demands benefitted more from the intervention. This suggests that the impact of the intervention on productivity could be mediated by a reduction in physical load factors. If the condition caused more functional impairment (productivity loss was more than 20 % at baseline or there was previous sick leave due to UED), it was found that the intervention was not effective. When the disability caused by UED was too severe, it seems that ergonomic interventions have less potential for restoring normal performance at work.

8.1.5. Comparison of two disability management methods

The target of this protocol was to describe a RCT with a study intervention of adjusting work (both work time and demands) to accommodate the disabled employee so that he or she would be able to continue working during recovery from a MSD (study question No V). This is believed to be the first RCT to investigate the effectiveness of early part-time sick leave in comparison to conventional full-time sick leave in musculoskeletal symptoms. The results and the increased knowledge will lead to a better decision making process regarding the management of disability related to MSD.

Despite the fact that part-time sickness absence has been made possible in many jurisdictions, this option has not been studied in a randomised controlled setting (Kausto et al. 2008). In addition, the results of study II show that more than every fourth employee coming to medical consultation because of MSD reported that they were partially able to continue working despite the disorder (table 8).

As pointed out earlier (Durand et al. 2007), in this type of intervention work becomes an object of the intervention itself posing several methodological challenges. In addition to the medical judgement by the physician, the intervention requires actions and decisions made by the employee, supervisor, colleagues and employer – each with their own values, objectives, interests, and training (Loisel et al. 2005).

Sickness absence is usually considered as a consequence of a health disorder rather than its treatment and, therefore, in most studies, it has been used as an outcome measure. In this trial, however, the mode of sick leave (part- or full-time) is used as an intervention to affect the outcome, i.e., the quantity of sick leave (cumulative number of sick leave days). The potential benefit of the intervention, i.e., the difference in the total number of full- or part-time sick leave days between the intervention and control groups, will mostly be attributed to the need for either additional part- or full-time sick leave during the follow-up period.

8.2. Methodological considerations

8.2.1. Study designs

The strength of this combination of studies is that they follow the course of disability (figure 4) recognising the four potential steps in the interventions. The studies represent systematic review, surveys (both cross-sectional questionnaire and baseline assessment), and randomised controlled trials.

Systematic review

The strength of the review is that it adhered to the systematic and rigorous Cochrane methods in searching the literature, selecting the interventions and study designs, as well as synthesising the data.

The measurement of the outcomes in the primary studies varied leading to considerable differences in the reported incidences of back pain. Another limitation was that all the required data could not be extracted from all studies, limiting the possibilities of pooling the data. In addition, the results of most of the studies had to be adjusted for the effect of cluster randomisation that had not been taken into account by the original authors.

It is not possible to exclude the possibility that the studies and the review lacked the power to detect a small but possibly relevant difference in the incidence of LBP. It is, however, highly unlikely that pooling the results of more studies would have found a significant beneficial effect. This is because almost all studies showed an OR that was near to 1, and the applied comparisons were all rather similar, especially as the use of a lumbar support can be considered equal to no intervention with respect to the prevention of back pain (Jellema et al. 2001). Only one study showed a more positive, but still non-significant, outcome (Yassi et al. 2001). This could be because the type of the intervention was different ("no strenuous lifting").

Surveys

In study II, one may question whether the patients were competent to assess the work relatedness of their symptoms. It can be argued that the patient's assessment is based more on illness-related problems at work rather than on occupational contributors of the illness, leading to over-reporting of work-relatedness. Different perceptions of work-relatedness by patients and their physicians have been regarded as a critical point of an effective consultation process (Plomp 1993). The workers' confidence in the OH physician is also based on their assessments of the physician's medical expertise and his/her understanding of the workers and their problems (Plomp 1992). In this study, however, the validity of patients' assessments of work-relatedness is supported by the similar occupational exposures reported by the patients and their physicians.

One potential source of systematic error in the two surveys is the so called "common source bias". When both the outcome (perceived disability or self-assessed productivity loss) and the study variables (for example, work-relatedness of the disorder or fear-avoidance beliefs) are inquired from the employee, this might lead to a common source bias (Podsakoff et al. 2003). People responding to questions posed by researchers can have a desire to appear consistent and rational in their responses and might search for similarities in the questions being asked of them. However, results similar to those described in study II and III have been reported also in other studies using more objective data sources.

In contrast to previous studies, the included subjects in studies III–IV were examined by a trained physician using standardized diagnostic criteria. On the whole, validated questions were used to collect information on several background variables. However, unmeasured confounding for example due to non-occupational or motivational issues may have affected the results.

The difficulty in quantifying productivity, particularly in information and service-type occupations, has led to a multitude of measurement instruments based on self-reporting. The QQ method by Brouwer was adapted by specifying it to concern UED, even if it was originally designed to be used for any disease. The strength of the QQ method is that the effect of the health condition on the quantity and the quality of productivity can be differentiated. Moreover, unlike the situation with many other questionnaires, there is a reference against which the loss can be compared, i.e., the respondents are asked to rate the attained quantity and quality of daily work compared to that of their regular work day. Naturally, there are other reasons for lost productivity that are not related to health. However, the QQ method takes into account these other reasons for production loss by using the regular work performance as an internal standard.

Moreover, the self-assessments were unlikely to have been affected by recall problems since the recall period of productivity was short in this study. For most employees, the preceding full regular working day was the day before the consultation or at most it was within one week. The short time frame also means that the productivity loss assessed in this study did not necessarily reflect longer lasting productivity loss. Considering the nature of clinical UED, it is, however, unlikely that the situation would change rapidly from one day to the next.

Randomised controlled trials

The randomised controlled design is considered as the least susceptible to bias in scientific intervention research. In study IV, the intervention and control groups were comparable without any major differences other than the intervention itself. The ergonomic intervention reached almost all subjects in the intervention group and more than 400 improvements were proposed.

Lifting at work and specific shoulder disorders were, however, somewhat more prevalent in the control group, whereas the proportion of elevated scores in fear-avoidance beliefs was higher in the intervention group. The subgroup analyses in this study showed that those employees who were exposed to lifting, forceful gripping or elevated arm postures or who had less fear-avoidance beliefs benefitted from the intervention more than those who had less physical exposures at work or more fear-avoidance beliefs. Therefore, these differences at baseline might have diluted the benefits of the intervention. Another fact that might have had a similar effect on the results is the method to replace productivity data at 12 weeks with the values at 8 weeks which had to be done for 8 subjects in the intervention group; this may have overestimated the remaining productivity loss at 12 weeks.

Since there are no objective measures for productivity in most occupations, the generally accepted method is to use self-assessed productivity as was done in this study. In previous intervention studies among employees with symptoms in the upper extremities and neck region, both objective and self-assessed productivity have been measured (van den Heuvel et al. 2003; Rempel et al. 2006). In comparison to these studies, the weakness of this present study is that that no objective measurement of productivity could be used, whereas the strength is that the disorders were medically verified using standardized diagnostic criteria.

In study V comparing the effects of part- and full-time sickness absence, it is essential that the physician determines the length of the disability before allocation, and adheres to this evaluation when prescribing either part- or full-time sick leave. This is to avoid bias that might occur if the length of the sick leave is determined differently for part- and full-time sick leave. There is a risk for bias related to the possible control visit, during which the allocation to further part- or full-time sick leave is again open to both the physician and the employee. In addition to recurrence of sick leave, an inappropriately timed return to regular work in either group could be anticipated to result in secondary outcomes, such as pain, functional status, employee satisfaction and financial costs to the employer.

Despite the extensive amount of quantitative data collected in this trial on individual, ergonomic, psychosocial and economic factors, it is not possible to quantify all the aspects of the arrangements made at the workplaces during part-time sick leave. Acknowledging the potential effect of this contextual process on the outcome of the intervention, all relevant qualitative data will be collected during the study from the employee and the supervisor.

8.2.2. Study populations

The studies have included only working individuals representing a wide range of employees in several occupations. Studies II–V included only workers whose musculoskeletal symptoms were verified by a physician, whereas self-reported LBP was registered in study I.

The review (study I) included studies with employees exposed to heavy lifting at work. The original aim was to include only prevention studies with workers without back pain at baseline. However, in the eligible studies there were always some workers already suffering from back pain at baseline. Therefore, this inclusion criterion had to be changed to workers who were not actively seeking treatment for current back pain.

The previously reported prevalences and magnitudes of productivity loss associated with MSD have been lower than that estimated in study III (Hagberg et al. 2002; van den Heuvel et al. 2007). The main reason may be that the previous studies have included subjects with self-reported symptoms, whereas in this study, subjects with the symptoms had sought medical advice, and for most of them, the physician diagnosed a specific UED. Hence, their condition was more severe and specific than simply an experience of pain.

The subjects in studies III and IV were actively working individuals from three companies with varying exposure to work-related factors. These individuals were seeking medical advice for their upper extremity symptoms. The intended number of study subjects was not gathered. Due to the relatively small population, the results are not very precise, as indicated by the width of the confidence intervals in study III, and there were some baseline differences in study IV. However, despite the limited study size, the results support the positive effects of an early ergonomic intervention.

The participation rate in study IV can be considered as high (88 %) during the 12 weeks' follow-up. However, due to the incomplete information at baseline and loss to follow-up, some selection may have occurred. It was analyzed whether those individuals lost to follow-up allocated initially to intervention or control group differed with respect to baseline variables. The conclusion was that the drop-outs and those with incomplete data in the intervention group reported a higher exposure to lifting and had higher levels of pain intensity and pain interference with work, leisure time and sleep than those in the control group. On the other hand, less productivity loss and fear-avoidance beliefs were reported by the drop-outs initially in the intervention group. If a selection bias due to non-participation had affected these results, it seems, however, unlikely that it caused any significant overestimation in the observed impact of the intervention.

The OHS staffs were requested to recommend study participation to all potentially eligible subjects, but there is no information about whether this was the case. Furthermore, it is not known how many subjects declined to participate. It is true that after being examined at the FIOH, none declined. This was originally an ergonomic intervention study, and it could be that those individuals with more severe symptoms (and lower productivity) were less likely to participate.

8.3. Implications for future research

The scope of the thesis is very wide, and therefore its potential to adequately answer all study questions is somewhat limited. Much research has to be performed in the future, before a significantly better understanding about MSD, disability and work will be achieved.

The systematic review on LBP and lifting advice revealed that there is a need for more and better quality research with standardised outcome measurement, appropriate power, and adjustment for the cluster effect. Such studies should be directed at a "no lifting policy". In addition a better understanding is needed of the causal chain between exposure to biomechanical stressors at work and the subsequent development of back pain to enable the development of new and innovative ways to prevent back pain.

Since most of the employees in studies on UED and associated productivity loss were female and working in a health care or office environment, the generalisation of the results of the intervention has to be somewhat limited. More research is needed on productivity loss and MSD in other work environments, such as heavy industry.

As the intervention in study IV had two parts, telephone contact with the supervisor by the physician and workplace visit by the physiotherapist, it is impossible to differentiate whether they both were crucial for the effect or if one (and which) would suffice. Therefore, more research is needed for to clarify which were the crucial parts of the intervention, but also in order to verify the results in different occupational settings.

One can always criticize that the results of studies II–V performed in the Finnish OHS may not be valid and applicable in other countries with a different kind of social security and OHS system. This is a justifiable criticism, because a significant amount of studies on MSD and disability have been performed in countries where the jurisdictions make a distinction between work-related MSD and other MSD. It is clear that all social security systems probably have some effect on interventions aimed at disability management, but this should not discourage research especially trying to translate successful models in one country for implementation in another.

8.4. Policy implications and recommendations

The studies of this thesis were performed in Finland, with the exception of the studies included in the systematic review (study I). In addition, most of the studies are results of collaboration between FIOH and OHS units. Therefore, the results are applicable to the Finnish social security and OH care system, and some conclusions as well as recommendations can be made based on the findings.

In addition to preventive services, the Finnish OHS can also offer primary health care level curative services to the employees. This offers possibilities for better management of employees with disabilities in addition to earlier recognition of health and safety risks at work during medical consultations. As in health care in general, it can be argued that the disability management by OH physicians has been mainly based on the biomedical model with too little emphasis placed on associated work-related, psychosocial and psychological factors (for details see chapter 2.2.).

The activities of the OHS personnel should be directed more towards disability management in order to meet the demands of the organisations and society on OHS. In 2005, tertiary disability management services to enable and support safe RTW were available in less than half of the Finnish OH units (Kivistö et al. 2008). The contents of the services were based on the current scientific evidence, but with substantial variation.

The results of this thesis challenge the biomedical model of disability prevention and management. The adaptation of biopsychosocial model in the disability management creates needs for training of both OHS personnel and the workplaces, as well as financial incentives for the employers to appreciate the value and to support the retention of employees with disabilities. When no medical cure is attainable, the individual's potentials can be identified and supported in order to enable his or her successful return to the modified work.

MSD are multifactorial in their nature, and therefore, apart from accident prevention, their elimination (primary prevention) by the means of work-related interventions is not realistic. There is more evidence available, to which this study adds, that recognition of MSD should lead to early analysis of both the work-related consequences and the employee's own perceptions concerning the disorder. Instead of keeping the employee out of work because of MSD, work activities can be modified and the negative consequences of the disorder minimised.

Most cases of LBP and many of UED are non-specific, and the so-called "objective" measures of pathology have been poor in predicting disability. There is convincing evidence that secondary and tertiary prevention of disability is effective if, after adequate medical assessment, the biopsychosocial aspects of the disorder and related disability are taken into careful consideration. Workplace, supervisor and colleagues should be included in the management of disability at an earlier stage if the disability is likely to be prolonged. As in studies IV–V, this necessitates collaboration and communication not only between the care provider and the employee, but also at the workplace with the supervisor and the colleagues. This approach most likely leads to stronger involvement and greater interest among supervisors in improving the work environment and support the employee with MSD. As a consequence, with an improvement of the supervisor's role and knowledge related to MSD, the results can benefit also all employees, with or without symptoms.

Based on the findings of this study the following recommendations can be made

1. The methods used for primary prevention of work-related MSD should be scrutinised. In those cases where their effectiveness is not supported by scientific evidence, the resources being allocated to them should be directed to more effective methods. Health professionals involved in training and advising workers on manual material handling should modify the contents so that no single lifting technique is advocated for lifting and handling. Instead, the aim should be to reduce lifting in the first place, and to prevent work accidents related to handling heavy objects.

2. The benefits of primary, secondary and tertiary prevention of disability are supported by credible evidence. Prevention of MSD at work is difficult because of their high prevalence and complex aetiology. However, there are evidence-based methods which are able to prevent the related disability. In the surveillance of MSD in the OHS, the employees' own perceptions of working conditions and their effects on musculoskeletal health should be used instead of simply relying on experts' assessments.
3. In the secondary prevention of disability, lost productivity at work due to MSD should be taken into consideration. This is important when supporting workers with MSD in continuing working, and when undertaking economic evaluations of the consequences of disability at work and of the interventions to reduce them. Often sickness absenteeism, pain or functional status might be too insensitive as outcomes to detect possible benefits of interventions.
4. A prerequisite for secondary prevention of disability is better knowledge and use of alternative models of the biomedical approach. At OHS, more efforts should be placed on early ergonomic interventions involving both the employees and their supervisors instead of wasting too much time in purely medical interventions. In this approach, the biopsychosocial model of disability management is more likely to benefit the employee than the biomedical model.
5. When assessing the work ability of the employee and his/her need for sick leave, attention should be paid not only to the medical condition but also to the psychosocial and psychological risk factors of the disability. This is pivotal for recommending the use of part-time sick leave or modified work instead of traditional sick leave in the management of MSD.

8.5. Conclusions

The five studies of this thesis aimed at answering five questions related to MSD, disability and work.

- The results of study I, a systematic literature review, do not support the use of training in lifting techniques with or without assistive devices as a way of preventing LBP and related disability among workers frequently exposed to heavy lifting.

- According to study II, MSD are responsible more often for self-assessed partial work ability than full inability to work, and workers more often than their physicians assess many of the health problems as being caused or exacerbated by work. Self-assessed work-relatedness of the disorder is associated with perceived disability.
- In study III, workers who did not need sickness absence nonetheless assessed UED to cause major productivity loss at work.
- In study IV, the management of UED related productivity loss showed that early ergonomic intervention at the workplace is superior to medical care only.
- The challenge of designing an RCT to study the effectiveness of part-time sick leave among workers with MSD was approached in the protocol devised in study V.

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I–V

Musculoskeletal disorders (MSD) are the most important causes of temporary and permanent work disability. The aim of this thesis was to examine the role of work in the disability caused by MSD from various perspectives: primary prevention using lifting advice and devices, perception of work-relatedness, measurement of productivity loss, and secondary/tertiary prevention through ergonomic intervention or part-time sick leave. The original articles include a systematic review, two surveys, a randomised controlled trial, and a study protocol. The results support the early use of a biopsychosocial model for effective management of disability.

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