Pain among employees

risk factors and consequences

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ACADEMIC DISSERTATION

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Abbreviations

CI	confidence interval
EFIC	The European Federation of IASP chapters
HPA	Hypothalamic-pituitary-adrenal
IASP	The International Association for the Study of Pain
OR	odds ratio
PCA	principal component analysis
RR	rate ratio
SF-36	Short Form 36 Health Survey

Abstract

The overall objective of this study was to gain epidemiological knowledge about pain among employee populations. More specifically, the aims were to assess the prevalence of pain, to identify socio-economic risk groups and work-related psychosocial risk factors, and to assess the consequences in terms of health-related functioning and sickness absence.

The study population consisted of the employees of the City of Helsinki, aged 40, 45, 50, 55, and 60 years. Two data sets were used: questionnaire survey data collected in 2000, 2001 and 2002, and employer personnel-register data on sickness absence. The main statistical methods were logistic regression analysis, analysis of covariance and negative binomial regression analysis. Pain measures included duration of pain (acute vs. chronic), the number of painful locations, and Von Korff's Chronic Pain Grade questionnaire.

Pain, and especially chronic pain, was common among the employees in question. Approximately 15 per cent of them reported acute pain and 29 per cent chronic pain, and about seven per cent had moderately or severely disabling chronic pain. Those with a low level of education or in a low occupational class were more likely to report pain than their better-off counterparts.

The associations of psychosocial work factors (job strain, organizational justice, bullying at workplace and the work-family interface) with pain were studied while adjusting for physical work factors and health behaviour. Among the women job strain and the work-home interface were associated with both acute and chronic pain, bullying was only associated with acute pain, and there were no associations between pain and organizational justice. Bullying was associated with acute pain among the men, job strain and organizational injustice were associated with chronic pain, whereas the work-home interface was unassociated with pain.

Pain was associated with lowered health-related functioning as assessed on the Short Form 36 survey. Both mental and physical functioning were affected, but the effect on physical functioning was stronger. The number of painful locations was associated with the widest variation in functioning. There was less variation in functioning depending on the bodily location of the pain or whether it was acute or chronic.

Further analysis revealed that pain predicted sickness absence during an average follow-up of three years. Self-certified absence was predicted approximately to the same extent by acute and chronic pain, but medically certified absence was more strongly predicted by chronic pain. The association was relatively independent of socio-economic status and physical and psychosocial working conditions. Of absence spells lasting between one on three days pain accounted for 13 per cent among the women and eight per cent among the men, the corresponding figures for absences lasting between four and 14 days being 23 and 25 per cent, and for absences lasting for over 14 days 37 and 30 per cent.

The results of this study provide a picture of the epidemiology of pain among employees. Pain is a significant problem that seriously affects work ability. Information on risk groups can be utilized to make prevention measures more effective among those at high risk, and to decrease pain rates and thereby narrow the differences between socio-economic groups. Furthermore, the work-related psychosocial risk factors identified in this study are potentially modifiable, and it should be possible to target interventions on decreasing pain rates among employees.

TIIVISTELMÄ

Kipu on merkittävä kansanterveydellinen ongelma. Se aiheuttaa inhimillisen kärsimyksen lisäksi taloudellisia menetyksiä kipua kokevalle henkilölle itselleen, hänen ympäristölleen sekä koko yhteiskunnalle. Viimeisten parin vuosikymmenen aikana kipua on tutkittu väestötasolla, mutta tietoa kivun epidemiologiasta tarvitaan edelleen sekä väestötasolla että pienemmissä ryhmissä. Erityisesti kivun esiintyvyydestä työssä käyvässä väestössä ei ole tarpeeksi tietoa, vaikka on selvää, että kivulla on merkittäviä vaikutuksia työkykyyn ja työntekijöiden hyvinvointiin.

Eläkkeellä olevan väestön määrän kasvaessa ja työikäisen väestön määrän pienentyessä joudutaan kiinnittämään entistä enemmän huomiota työntekijöiden terveyteen ja työkykyisenä pysymiseen vanhuuseläkeikään asti. Sen vuoksi tarvitaan tutkimustietoa kivun yleisyydestä työntekijöillä, työhön liittyvistä riskitekijöistä ja siitä, minkälaisia seuraamuksia kivusta koituu toiminta- ja työkyvylle. Ymmärtämällä kipuongelman laajuus ja sen seuraukset sekä tunnistamalla riskitekijöitä voidaan esimerkiksi työterveyshuollon toimin pyrkiä ehkäisemään kivun syntyä tai kroonistumista ja sitä kautta myös kivun kielteisiä seurauksia.

Tämän tutkimuksen tarkoituksena oli: 1) kartoittaa kivun yleisyyttä 40-60 -vuotiailla Helsingin kaupungin työntekijöillä, 2) tunnistaa erityisiä sosiodemografisia tai sosioekonomisia riskiryhmiä, 3) tutkia työhön liittyviä psykososiaalisia riskitekijöitä ja 4) selvittää kivun seurauksia suhteessa työ- ja toimintakykyyn.

Tutkimuksen aiheistona on Helsingin kaupungin työtekijöiden terveystutkimus, joka koostuu 40, 45, 50, 55, ja 60-vuotiaille kaupungin työntekijöille vuosina 2000-2002 lähetetystä postikyselystä (n=8960) sekä Helsingin kaupungin henkilöstörekisterin tiedoista. Aineisto kattaa laajan kirjon erilaisia ammattiryhmiä. Kyselytutkimusaineisto on poikkileikkaustutkimus. Kivun seurauksia suhteessa sairauspoissaoloihin tutkittiin seuranta-aineistolla, joka muodostettiin yhdistämällä kyselyaineisto ja henkilöstörekisterin tiedot sairauspoissaoloista kyselyajankohdan jälkeiseltä kolmelta vuodelta.

Kipua tarkasteltiin neljästä eri näkökulmasta: 1) kivun kesto (akuutti eli korkeintaan kolme kuukautta kestänyt kipu ja krooninen eli yli kolme kuukautta kestänyt kipu), 2) kivun haittaavuuden aste (Von Korffin kipuasteikko) 3) kivun sijainti ja 4) ilmoitettujen kipualueiden lukumäärä. Kivun kestoon perustuvaa

mittaria käytettiin läpi koko tutkimuksen. Kivun haittaavuutta kuvaavaa mittaria käytettiin tutkittaessa kivun esiintyvyyttä ja riskiryhmiä. Kivun sijaintiin ja lukumäärään liittyviä mittareita käytettiin tutkittaessa kivun yhteyksiä terveyteen liittyvään toimintakykyyn. Toimintakykyä tutkittaessa vasteena oli Short Form 36 mittari ja työkykyä tutkittaessa sairauspoissaolot. Riskiryhmätutkimuksissa keskeiset muuttujat olivat sosioekonomiset ja sosiodemografiset tekijät. Riskitekijätutkimus keskittyi erityisesti psykososiaalisiin työoloihin, mutta niissä huomioitiin myös fyysiset työolot, terveyskäyttäytyminen sekä ammattiasema.

Tulosten mukaan kipu ja erityisesti krooninen kipu on yleinen ongelma ikääntyvillä työntekijöillä. Vastaajista noin 15 % raportoi kokevansa akuuttia kipua parhaillaan ja 29 % raportoi kokevansa kroonista kipua. Hyvin haittaavaksi kroonisen kivun koki n. 7 %. Kipu oli yleisempää vanhemmilla työntekijöillä ja niillä, joilla oli vähän koulutusta tai alhainen ammattiasema. Useiden työhön liittyvien psykososiaalisten tekijöiden havaittiin olevan yhteydessä kipuun. Naisilla tällaisia tekijöitä olivat korkea työstressi, työpaikalla esiintyvä kiusaaminen, sekä työn ja perheen yhteensovittamisen ongelmat, joista kiusaaminen oli yhteydessä akuuttiin kipuun ja työn ja perheen yhteensovittamisen ongelmat krooniseen kipuun. Työstressi sen sijaan oli yhteydessä molempiin kiputyyppeihin. Myös miehillä korkea työstressi ja kiusaaminen olivat yhteydessä kipuun. Työstressi oli yhteydessä krooniseen kipuun ja kiusaaminen akuuttiin. Sen lisäksi, naisista poiketen vähäinen oikeudenmukaisuus organisaatiossa lisäsi kroonisen kivun raportointia. Työn ja perheen yhteensovittamisen ongelmat sen sijaan eivät olleet yhteydessä kipuun miehillä.

Terveyteen liittyvä toimintakyky oli selkeästi heikentynyt kipua raportoivilla työntekijöillä verrattuna kipua raportoimattomiin. Sekä psyykkinen että fyysinen toimintakyky oli alentunut kipua raportoivilla, jälkimmäinen kuitenkin voimakkaammin. Kun verrattiin, kipujen sijainnin, kipualueiden lukumäärän ja kivun keston keskinäistä merkitystä suhteessa toimintakykyyn, todettiin että kivun yhteys toimintakykyyn ei juurikaan riippunut sijainnista kehossa. Myöskään sillä oliko kipu akuuttia tai kroonista, ei ollut suurta merkitystä. Sen sijaan suurimmat erot toimintakyvyssä todettiin kipujen lukumäärän mukaan. Mitä useammalla kehon alueella kipua raportoitiin, sitä huonompi oli toimintakyky.

Kivun seurauksia tutkittiin myös sairauspoissaolojen näkökulmasta. Krooninen kipu ennusti poissaoloja akuuttia kipua selvemmin. Ammattiasema, fyysiset ja psykososiaaliset työolot vaikuttivat vain vähäisessä määrin kivun ja sairauspoissaolojen väliseen yhteyteen. Kivun aiheuttama kuorma (etiologinen

fraktio) 4-14 päivää kestäneissä lääkärin määräämissä sairauspoissaolojaksoissa oli 23 % naisilla ja 25 % miehillä. Yli kaksi viikkoa kestäneiden lääkärin määräämien sairauspoissaolojaksojen osalta kuorma oli noin 37 % naisilla ja 30 % miehillä. Lyhyissä alle 4 päivän poissaolojaksoissa kuorma oli huomattavasti pienempi (13 % ja 8 %).

Tämä Suomen suurimman kaupungin kuntatyöntekijöitä koskeva tutkimus toi esiin selkeitä kivun riskiryhmiä ja työhön liittyviä psykososiaalisia riskitekijöitä sekä osoitti kuinka mittavia vaikutuksia kivulla on terveyteen liittyvään toimintakykyyn ja sairauspoissaoloihin. Kohdistamalla ennalta ehkäiseviä toimenpiteitä erityisesti alemmassa ammattiasemassa oleviin ja vähän koulutusta saaneisiin ryhmiin sekä vaikuttamalla edullisesti psykososiaaliseen työympäristöön voidaan pyrkiä sekä ennaltaehkäisemään että vähentämään kipuongelmia työntekijöiden keskuudessa.

1. INTRODUCTION

Pain is an inevitable part of human life. It is present as a symptom in many illnesses and diseases, but can also occur without any detectable pathology (IASP International Association for the Study of Pain, 1994). It gives a compelling reason to seek relief and care. Despite its unpleasantness, however, it is essential for survival. It warns of threat and gives a valuable signal of injury or tissue damage. For example, a strong pain in the lower right-hand part of the abdomen, which is a typical symptom of an inflamed appendix, signals the need for acute treatment. Another task of acute pain is to foster healing in that it forces the sufferer to rest the injured part of the body. However, if acute pain persists beyond the normal healing time it becomes chronic, a physical and psychological burden, or as The European Federation of IASP Chapters (EFIC) states: a disease in its own right (EFIC declarations on pain).

Pain can be considered a significant public health problem. According to recent population studies, up to 20-35 per cent of people suffer from chronic pain (Mäntyselkä et al. 2003; Breivik et al. 2006). In addition to this high prevalence, the duration is typically long – several years on average (Breivik et al. 2006). Pain causes human suffering and disability. It affects work ability and may force people out of working life (Breivik et al. 2006). In terms of health care resources, pain patients constitute a significant burden: 40 per cent of visits to general practitioners in Finland are associated with pain (Mäntyselkä et al. 2001). It is estimated that one visit to a general practitioner due to musculoskeletal problems, including laboratory tests, x-rays and sickness absence, costs 530 euro (Mäntyselkä et al. 2002). In addition, the use of pain medication is widespread: it was found in a Finnish population study, that 9 per cent of the population used pain medication daily, and an additional 14 per cent several times a week (Turunen et al. 2005). It has been estimated that the total costs of just musculoskeletal pain amount to three per cent of the gross national product of Finland (Mäntyselkä et al. 2002).

Hitherto much research effort has, for obvious reasons, been targeted at the alleviation of pain, the main focus being on biological mechanisms and treatment. However, although alleviation is necessary, it is equally important to be aware of the factors contributing to pain and of its consequences on the population level. Population level actions related to health can achieve significant results. Epidemiological information on the risk factors of pain is needed in the search for

effective prevention. Knowledge about the consequences of pain is also required in order to understand the scale of the problem and to motivate preventive actions.

Epidemiological studies on pain have been mostly carried out among general populations. Research among employees has typically focused on specific painful conditions such as low back pain and diagnoses such as fibromyalgia. Thus, although the active labour market is dependent on healthy employees, there is almost a complete lack of epidemiological investigation giving a wider view on the prevalence, risk factors and consequences of chronic pain among employee populations. Studies carried out among general populations rarely include more than a few questions on the work environment and related exposures, and therefore do not reveal the specific associated risks and consequences. There is a need for research focusing directly on employees that allows the inclusion of a wider range of work-related factors of interest and assessment of the consequences of pain on work ability in current working life. The nature of working life has shifted during the past 20-30 years from industrial towards service and information work. The constant flow of new information and the challenges involved in absorbing it are greater than ever before. All this means that whereas heavy physical work demands have decreased, psychosocial demands have increased significantly. Thus, there is a need for research specifically on the effects of the psychosocial work environment on pain.

The present study is based on research data covering municipal employees and was collected at the beginning of the 21st century. The data reflects the labour-market situation at that time among ageing municipal employees in Finland's largest city, Helsinki.

The purpose of the study is to find out how frequent a complaint pain is among employees, whether there are particular high risk groups, how job characteristics are associated with pain problems, and how pain affects work ability. The results give novel, up-to-date evidence on the socio-demographic and socio-economic risk groups, the work-related psychosocial risk factors and the consequences of pain, and especially of chronic pain, among employees of Finland's largest municipality. On the basis of the findings reported here, it is possible to estimate the scope of the pain problem for use in health care planning. Prevention, treatment and rehabilitation can be focused more directly on the most significant risk groups and risk factors. Occupational health care professionals, in collaboration with employers, will be able to use the information on risk groups

and risk factors in their efforts to tackle work disability, pain-related sickness absence and early exit from work.

2. Conceptual background

This chapter provides the relevant conceptual and theoretical background for this epidemiological study. It begins with a general characterization of pain and continues with a brief description of physiological pain processes and a summary of some current pain theories and models. The grounds for considering pain a generic health outcome in epidemiological studies are set out and various pain categorizations are described. A definition of pain as applied in the study is given. Finally the focus turns to the socio-economic and psychosocial background of pain processes.

2.1 Pain

According to current understanding, pain is a subjective sensorial and emotional experience. The commonly accepted and often used definition provided by the International Association for the Study of Pain (IASP 1986) is as follows: "Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage". The last part of the definition “or described in terms of such damage” emphasizes the fact that the experience of pain is affected not only by physical factors but also by psychological factors and the social environment. It also suggests that sometimes no proximate physical cause for pain can be identified (IASP pain terminology at http://www.iasp-pain.org).

2.1.1 Physiological pain processes

Physiological pain processes are not the focus of this study, but they nevertheless play an important role in that they constitute the physiological background of pain. Thus, brief reference is made to those processes in order to give as comprehensive an account of pain as possible.

According to current knowledge of the physiological process, pain occurs when nociceptors are activated by noxious stimuli, which may be mechanical (touch or pressure), thermal (hot or cold) or chemical (endogenous or exogenous). The pain signal is detected by the peripheral nervous system and transmitted to the brain via the spinal cord in accordance with the following four process (see Renn and Dorsey 2005; Todd and Koerber 2006; Woolf and Salter 2006; Busnell and Apkarian 2006; Fields et al. 2006): 1) The transduction occurs when the noxious

stimulus is detected by nerves that respond to pain stimulus, i.e. nociceptors (peripheral nerves). 2) The transmission occur when the pain signal travels as an electrical action potential along the A-delta and C primary afferent nerve fibers to the grey matter of the spinal cord and to the dorsal horn, where the first exchange of information takes place. If the pain sensation is severe, afferent motor fibers cause withdrawal reflex. When the nociceptive signal is received in the dorsal horn, projection neurons transmit the information to higher centres in the central nervous system. 3) The modulation occurs when the pain signal arrives at the brain and triggers a network of brainstem structures and pathways that exert their modulatory effect on the nociceptive transmission. Descending pain pathways modulate the perception of pain by inhibiting or facilitating the pain signal (nociceptive transmission) – in other words pain may be either strengthened or dampened by the nociceptive signal. 4) The perception occurs when the signal reaches the thalamus. The nociceptive information is encoded prior to being sent onwards to the limbic structures and cortical sites. The pain is analyzed in the brain. The signal is integrated in the somatosensory cortex and undergoes cognitive and emotional interpretation, in other words, is interpreted as pain. This involves the sensory-discriminative components of the pain experience - perception of the intensity, location, duration, temporal pattern and quality of the noxious stimuli - and the motivational-affective components including the relationship between pain and mood, attention, coping, tolerance and rationalization.

2.1.2 Current theories and models of pain

Several theories and models have been developed in attempts to capture the nature of pain. The biomedical model, according to which pain is a direct effect of a tissue damage and is strictly proportional to it, was widely used for a long time, but is now being replaced by newer, more advanced models. This section briefly describes some of the current theories and models. The gate-control theory and the neuromatrix theory of pain are mainly related to physiological processes. The biopsychosocial model represent attempts to combine the biological, psychological and social factors affecting the pain experience, and the socio-cultural model focuses on the significance of the social and cultural environments. These theories and models are not utilized in this study as such, but they nevertheless provide background material that facilitates understanding of the concept of pain.

THE GATE-CONTROL THEORY AND THE NEUROMATRIX THEORY OF PAIN

Meltzack and Wall's (1965) gate-control theory and Meltzack's (2001) neuromatrix theory of pain concentrate mostly on biological processes but simultaneously take into account the modifying effect of psychological factors. The gate-control theory was the first to acknowledge the complex nature of pain and the significance of psychological factors. It stresses the role of the central nervous system in pain processes. Brain is seen as an active system which filters, selects and modulates inputs (Meltzack 1999). It also highlights the inhibiting, exciting and modulating capacities of descending pain pathways and the role of the dorsal horn in this process (Melzack 1999a). For example, rubbing the painful site could reduce the pain reserving the same 'gate' in the dorsal horn as the pain signal and thus inhibiting the flow of pain signals to the brain. The later neuromatrix theory represented a further effort to better capture the complexity of pain (Meltzack 1999a, 2001). According to the theory there is a complex network of nerve cells in the brain that are involved in the pain experience. This network creates and remembers the 'body-self'. The theory is based on the notions of phantom limb pain, when patients feel pain in a limb that has been removed. The 'body-self' explains why pain can still be felt in a non-existing limb (Melzack 1999a, Nielson 2001). According to Melzack (2001) pain is a "multidimensional experience produced by multiple influences" in other words it may be affected by stress reactions, previous experiences and expectations, for example (Estlander 2003).

THE BIOPSYCHOSOCIAL MODEL

The biopsychosocial model of pain has attracted wide attention in the field of pain research in recent decades. It combines biological, psychological and social factors affecting pain, positing that pain occurs in interaction with these factors (Gatchel et al. 2007). Pain is a physiological reaction to a painful stimulus (tissue damage, disease), which is simultaneously affected by psychological (thoughts, emotions, beliefs), and social (family and work environment, socio-cultural environment) factors (see Keefe and France 1999). It is also considered a dynamic process that is affected by the aforementioned factors but also produces changes to them, which in turn affect the future experience of pain (Keefe and France 1999). The model provides a tool with which to integrate different factors affecting pain on different levels. It is more advanced model than the previously widely used biomedical model, according to which pain is a direct effect of tissue damage and is proportional to it (Gatchel et al. 2007). However, it also has limitations. Even

though biological, psychological (often described in terms of anxiety, depression, fear avoidance, and catastrophizing, for example) and social factors are assumed to interact, the model often describes these factors separately. Thus, the role and position of psychosocial factors such as job strain, for example, in this model remain unclear. The main strength of the model is that it brings out the different aspects that modify pain processes. However, if it is to provide a clearer conceptual basis for pain research in the future it needs to be more specific, and the interactions between the different levels should be elaborated and operationalized in more detail.

THE SOCIO-CULTURAL MODEL

Expressions of pain are also shaped by the social and cultural environment. Some cultures value quiet suffering and high endurance of pain, whereas in others vivid and loud complaints are normal forms of expression (Sachs 2003). Socio-cultural environments determine acceptable pain behaviour and how pain is shown to others. There are differences between nationalities, and also between social groups (Hobara 2005) stratified by gender or socio-economic status, for example. It may be that women express pain more strongly than men simply because they are allowed to do so in terms of behavioural norms, at least in western societies. In terms of socio-economic differences those with more resources may be keener to find out the medical reason for the pain, in other words they seek care more frequently than those with fewer resources. Thus it is important to see pain not only as an individual experience, but also as an experience shaped by the social and cultural environment (Vaskilampi 1992; Sachs 2003; Toates 2007).

THE RELEVANCE OF CURRENT PAIN THEORIES AND MODELS TO THE PRESENT STUDY

Elements of the biopsychosocial model and the socio-cultural model are utilized in this epidemiological study, acknowledging that pain has a physiological background. It is assumed that the social structure relates directly to the epidemiology of pain through the socio-economic status the employee has achieved. In addition, the social and cultural environments shape the psychological experience of pain through the psychosocial environment. Thus, the framework of this study incorporates information about both the social structure as well as the interaction between the social and psychological environments, i.e. the psychosocial environment.

2.2 Pain in epidemiological studies

2.2.1 Pain regardless of the location or diagnosis

It is common to study pain in terms of disease or as a symptom of disease. However, there are reasons why it is also useful to study pain as such in epidemiological studies, regardless of the location or diagnosis. First, pain is rarely proportional to the original tissue damage (Keefe and France 1999). Regardless of the aetiology or biological cause, the experience of pain is relational to the psychological, social and cultural environment of the pain sufferers. Secondly, it is common for pain to occur simultaneously in more than one bodily location (Andersson et al. 1993; Urwin et al. 1998; Picavet and Schouten 2003). Therefore, in an epidemiological study with a public health perspective, it might not be easy to disentangle the effects of any single instance of pain from the total burden. Thirdly, the risk factors associated with the onset or persistence of a disease might be different from those affecting the onset or persistence of pain related to it. Moreover, pain is not always present even though the underlying disease is. Fourthly, there is some pain, especially chronic pain, which cannot be traced back to the biological processes referred to above, and this would be left outside studies if only diagnosed pain was in focus. Thus, studying pain as a general phenomenon is more effective in terms of assessing its broad epidemiological and public health significance than focusing separately on specific pain-related diseases, and diagnoses, or single locations.

Given that pain is without doubt a major correlate of health and well-being, there are good grounds for seeing it as a generic health-related outcome, similar to self-rated health, for example. Self-rated health is a broad and valid measure of generic health (Manderbacka 1998) that has turned out to be a significant predicator of mortality as well (e.g., Idler and Benyamini 1997; Singh-Manoux et al. 2007; Jylhä 2009). Studies have shown that self-rated health is strongly affected by pain (Eriksen et al. 2003; Mäntyselkä et al. 2003; Smith et al. 2004), and this association is relatively independent of the underlying chronic disease (Mäntyselkä et al. 2003). This therefore supports the examination of pain as a generic health outcome. Moreover, there is evidence that like self-rated health, pain predicts mortality (Macfarlane et al. 2001; Andersson 2004). As a generic health-related outcome it covers the total burden of pain in its different forms.

Pain is essentially a subjective experience and cannot, therefore, be measured objectively like blood pressure and haemoglobin, but hints at its severity may be gleaned from the sufferer's behaviour. He or she may be rubbing the painful body part or avoiding touching or moving it, moaning, or looking pale and sweaty. The blood pressure may be elevated or the breathing rate faster. However, direct observation is expensive and time consuming. It is therefore rare in epidemiological studies which rely mainly on respondent self-reports. Assessment of pain, based on self-reports, is possible on various dimensions, such as duration, frequency, location(s), severity, and the consequent degree of disability caused by it. These may be measured on separate questions, or with specially designed pain indices, such as the Chronic Pain Grade questionnaire (von Korff et al. 1992), which measures different aspects of pain intensity and disability. There are also several pain-rating tools, such as the Visual Analogue Scale, which give information about the intensity (e.g., Winkelman et al. 2008), but they are more commonly used as technical tools by health care professionals than in scientific epidemiological studies.

Finally, it has to be noted that advanced biological information about pain is obtainable from brain imaging. It is a valuable source of information in the continuing effort to understand physiological pain processes (e.g., Raij 2005).

2.2.2 Categorizations of pain

Pain could be considered as 'any pain', as in this thesis, but even when the focus is on the general phenomenon, some type of categorization is useful in order to obtain more detailed information.

There are several ways of categorizing pain. One categorization that is frequently referred to in the literature is based on biological pain mechanisms (nociceptive, neuropathic or idiopathic pain), but it is rarely used in epidemiological studies and is more of a diagnostic aid. Categorizations in the research field are commonly based on disease or diagnosis, duration (acute, chronic) or frequency of pain episodes, location (e.g., back pain, musculoskeletal pain, widespread pain, number of painful locations), intensity, and resulting disability, for example. Those used in this study are based on duration, location and disability and are explained in more detail in the following sections.

Acute and chronic pain

According to the IASP definition, pain becomes chronic when it persists longer than three months (IASP 1986). Thus, pain lasting three months or less is considered acute. The IASP definition is based on a time cut-off point that was selected by a group of pain experts and is based on the assumed length of time that tissue damage takes to heal.

Acute pain is generally considered to differ essentially from chronic pain. It is protective, it warns of a threat to one's health, prevents the use of a damaged body part and therefore fosters healing. It is typically of short duration, usually has identifiable causes and is restricted to the site of the injury (Renn and Dorsey 2005). It also responds well to treatment (Kalso and Vainio 2009). Chronic, prolonged pain that persists beyond the normal tissue-healing time, however, cannot be considered protective but as emotionally and physically stressful (Kalso and Vainio 2009). It typically has no identifiable causes and no biological functions (Renn and Dorsey 2005). In the worst case, prolonged pain, that is not accurately medicated can produce irreversible changes to the nervous system, which transmits and interprets the messages. This may expose the sufferer to sensitization or to prolonged and intensified pain (Keefe and France 1999).

Even though the three-month cut-off point for chronicity is common in scientific studies, it is not rare to use six months (e.g., Eriksen et al. 2003). Definitions of chronic pain based on time cut-off points used in scientific studies may include additional conditions such as: "pain every day for three months during the prior six months" (Blyth et al. 2001); "pain continuously or intermittently for longer than three months" (Elliott et al. 1999); "pain present most of the time for a period of six months or more during the prior year" (Gureje et al. 1998); "pain for at least six months with an experience of pain in the last month and at least two times per week with an intensity at least five on a 10-point scale" (Breivik et al. 2006). Thus, definitions of chronic pain vary a lot, and this makes it difficult to reach a common understanding of its prevalence across nations or groups of people.

Defining chronic pain by duration has attracted criticism in recent years. It is argued that such a definition does not reveal whether long-lasting pain is clinically significant, in other words what its future course is (Von Korff and Dunn 2008; Thomas et al. 2008). Von Korff and Miglioretti (2005) recently developed a new risk score based on a complex algorithm that aims to detect the future significance

of the pain in terms of outcome. This risk score has been tested on patients with low back and knee pain (Thomas et al. 2008) and there is evidence that it could prove to be a more effective approach than the IASP definition. However, more research is needed. Thus, until any new commonly accepted definition is taken into use, the IASP definition offers the best potential for comparison of the results of various epidemiological studies. Other complementary measures may be used such as the number of locations and severity of pain.

Location(s)

It is common in pain studies to focus on certain bodily location(s). This can be done with the help of manikin, a picture of the human body on which the respondent can mark all the locations where s/he feels pain, or by producing a written list of possible locations. However, it should be noted that the information thus obtained does not reveal whether the origin of the pain is musculoskeletal for example, unless additional information is provided. The marking of bodily locations facilitates calculation of the number of painful locations which is sometimes used to give information about whether pain occurs simultaneously in multiple locations. An additional and quite frequently used definition based on location is that of widespread pain, which usually refers to fibromyalgia type of pain. It is defined according to the American College of Rheumatology (Wolfe et al. 1990) as pain in both the left and right side of the body, and above and below the waist. It is usually compared to regional pain, which is any pain(s) not fulfilling the criterion of being widespread.

Severity

The consequences of pain are dependent on the degree of severity. Information on severity gives an estimate of the extent of the consequences in terms of subjective suffering and functional capacity. Measurement includes assessing how intense the pain is and how disabling it is in the sufferer's normal life, work and other daily tasks. Although intensity and disability are distinct dimensions, they are highly correlated (Von Korff 1992). One example of a severity measure is Von Korff's pain questionnaire, which combines the aspects of intensity, disability, and the duration of the disability thereby giving an overall picture of how severely disabling and limiting the pain is.

2.2.3 THE CONCEPT OF PAIN IN THIS STUDY

The focus in this study is on pain as a subjective and self-reported experience. Pain is viewed as a general phenomenon, a generic health-related measure, which reflects health and well-being. It is acknowledged that it is affected by physiological, psychological and social factors. Several measures of pain are utilized: acute vs. chronic pain, severity, bodily location, and the number of painful locations.

2.3 ENVIRONMENTAL FACTORS ASSOCIATED WITH PAIN PROCESSES

A wide variety of environmental factors are associated with health and well-being, and such factors are likely to produce differences in health between groups of people. The key factors in social epidemiology include those related to the socio-economic, the socio-demographic, and the psychosocial environments. The major focus in this study is on these factors.

2.3.1 SOCIO-ECONOMIC FACTORS

Socio-economic status is a significant determinant of health among populations including employees. Those in lower socio-economic positions are more likely to rate themselves lower with regard to health, symptoms, diseases, illness and premature death than those in higher positions (e.g., Mackenbach et al. 2008). Social gradients in health are common and the availability of material, cognitive and psychosocial resources for example is associated with the differences (Laaksonen et al. 2005; Marmot 2005; Mackenbach et al. 2008). The socio-economic factors applied in this study are closely related to differences in occupational hazards, knowledge, and financial resources. Occupational class is associated with differences in occupational exposures: those with lower occupational class are likely to have more physically straining work than those in higher classes, for example. Education is associated with differences in knowledge and resources in terms of obtaining information about health or avoiding risks. Income and housing tenure are associated with financial resources, and with differences in access to care, or an optimal environment in terms of health. It is not only material disadvantage, but also adverse social and psychological circumstances related to one's socio-economic position (i.e. stress related to psychologically demanding work, lack of control over one's work and home life,

and social isolation) that can cause stress, which is one of the potential mechanisms through which the differences are mediated (see Lynch and Kaplan 2000; Galobardes et al. 2006).

Socio-economic status is a broad concept that is measured on a variety of indicators, as described above. Its various aspects are likely to be at least partly overlapping, but may also represent independent aspects (Lahelma et al. 2004; Laaksonen et al. 2005; Galobardes et al. 2005). Establishing the mutual importance of the different aspects with regard to pain requires the simultaneous study of several of them.

Socio-economic factors can affect health though causation or selection. Longitudinal studies support the causation hypothesis (Blane et al. 1993; Goldman 2001). It is assumed in this study that the effect is causal, in other words that health is affected by the risks associated with a person's socio-economic status. These risks cumulate over the life course and may concentrate on the same people (Davey Smith et al. 1997).

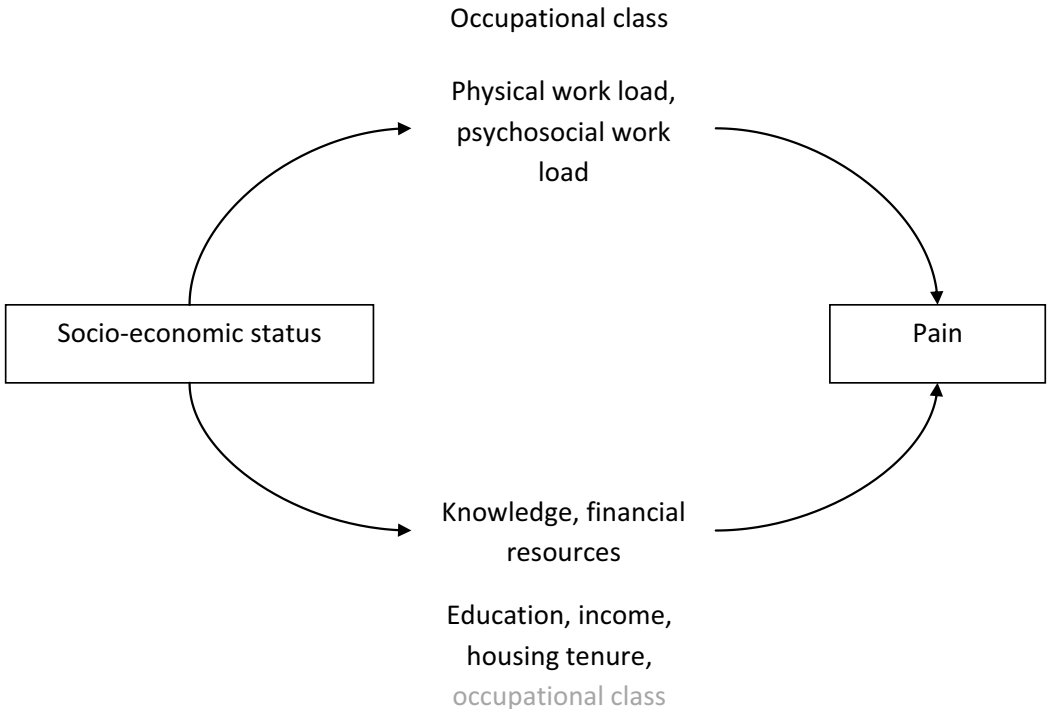


Figure 1. *Potential routes of the effects of socio-economic factors on the pain process*

2.3.2 Psychosocial factors

As mentioned previously, the actual amount of pain is rarely proportional to the strength of the noxious stimuli. This leads to the conclusion that the amount of pain produced by such stimuli is associated with the broader context in which the pain is felt, experienced and reported, in other words the psychological, social and cultural situation in which pain occurs (Toates 2007). The psychological and social environments affect pain and may be discussed separately, but the main focus in this study is on the area in which the two interact, in other words on the psychosocial factors. Psychosocial factors here thus refer to psychological phenomena (e.g., emotions, cognitive functions) that relate to the social and organizational environments and are potentially harmful to health, such as job strain (Hemingway and Marmot 1999, Cox et al. 2003). The routes through which such psychosocial factors may affect pain are illustrated in Figure 2, and include the following: adverse psychosocial factors may expose people to pain, they may affect the perception/experience of pain by increasing or decreasing it, or they may contribute to its persistence (Estlander 2003). Furthermore, pain may be directly triggered by psychogenic factors, but this is quite rare. Interaction effects with biological factors are, however, common (Turk and Okifuji 2002).

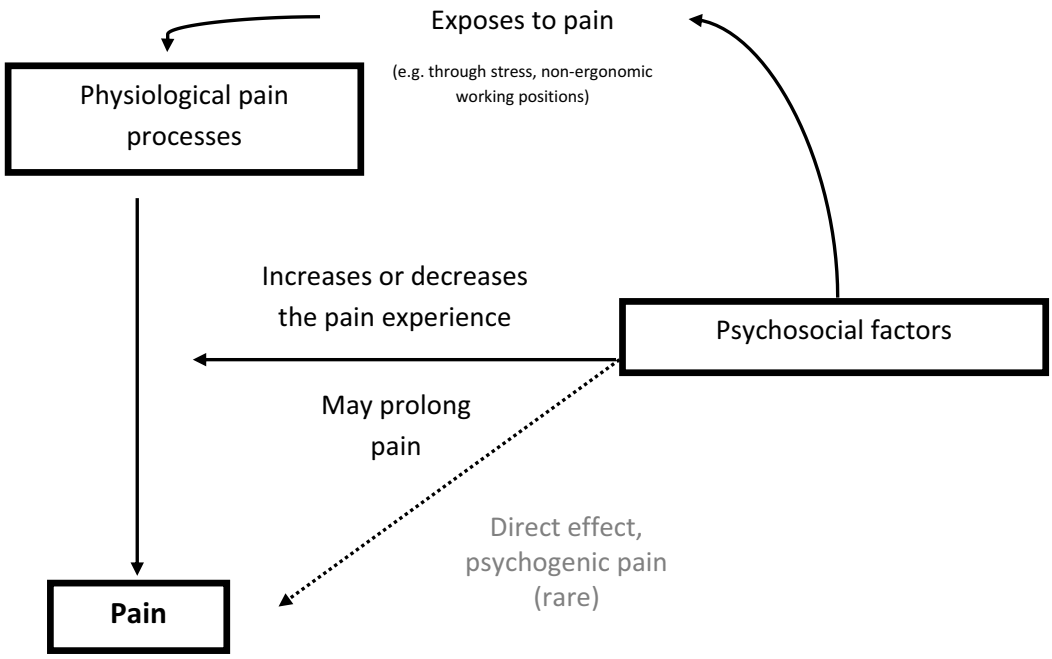


Figure 2. *Potential routes of the effects of psychosocial factors on the pain process*

Whereas the potential routes of the effects of psychosocial factors can be identified, the mechanisms through which they affect pain are not yet sufficiently understood, although stress is a probable mediating factor. Physiological stress reactions (e.g., elevated blood-sugar levels and increased metabolism, and a suppressed immune system) are known and may, when prolonged, affect muscle, bone and neural tissue directly or by predisposing to vulnerability to forthcoming stressors that trigger harmful effects in terms of pain (Melzack 1999b). Furthermore, stress may negatively alter the experience of pain and affect coping abilities. Indeed, stress and psychological strain may also increase muscle tension, which may further contribute to pain (Lundberg et al. 1994). This could bring about behavioural change, make employees change their working methods and postures (Bongers et al. 1993), or impose an increased biomechanical load via increases in muscle co-activation and less controlled movements (Marras et al. 2000).

The psychosocial work environment is a broad area incorporating aspects of the job (e.g., busyness, high requirements), social networks, conflicts between employees (e.g., bullying), management (e.g, fairness of decision-making), and the interplay between work and private life, for example. Various psychosocial factors are likely to partly overlap and partly reflect the same underlying comprehensive work environment. It is therefore important to consider the effects of these factors both separately and jointly with pain.

3. A REVIEW OF THE PREVIOUS EMPIRICAL RESEARCH

This literature review covers firstly large-scale population level studies on pain, focusing on prevalence rates and socio-demographic as well as socio-economic risk groups. Given the lack of research on the prevalence of pain among employees, these studies provide basis for comparison with the rates found in the present study. Secondly, it includes studies on risk factors of pain among employees with special attention to psychosocial risk factors. Finally, studies on the consequences of pain are reviewed with special attention to health-related functioning and sickness absence. Whenever possible, the studies reviewed use pain outcomes similar to those applied in this study, otherwise they focus on located pain, such as in the low back pain.

3.1 THE PREVALENCE OF PAIN

Definitions of chronic pain vary, and this affects reported prevalence rates. According to a recent Finnish study (Mäntyselkä et al. 2003) 35 per cent of the population reported chronic pain and 14 per cent reported daily chronic pain. A Swedish population-based study (Andersson et al. 1993) reported a prevalence of 55 per cent for chronic pain. According to a Norwegian study (Rustøen et al. 2004a), 24 per cent of the population suffered from chronic pain whereas in Denmark and Australia 19 per cent reported chronic pain (Eriksen et al. 2003; Blyth et al. 2001). However, national variation is not necessarily this wide. For example, the cut-off point for chronic pain in the above mentioned Norwegian (Rustøen et al. 2004a) and Australian (Blyth et al. 2001) studies was set at three months whereas in the Danish study (Eriksen et al. 2003) it was six months. Moreover, some studies include extra criteria for the frequency of chronic pain. Blyth et al. (2001), for example, stipulated that the pain had to be experienced every day for three months, which has likely brought down the rate to some extent. The Swedish (Andersson et al. 1993) and the Finnish (Mäntyselkä et al. 2003) studies included regularly recurring pain in addition to persistent pain. However, the high prevalence of chronic pain reported in this Swedish study clearly deviates from the results of studies conducted in neighbouring countries.

Prevalence rates are affected by differences in the study samples, sampling methods and response rates. Most of the population studies referred to here were based on national random samples, although some were limited to regional

samples. Telephone interviewing, which was used in the Australian study (Blyth et al. 2001), excludes those without a telephone or with an unlisted number, for example. Response rates in the aforementioned studies varied from 49 to 90 per cent. The age distributions varied, too. Table 1 gives more detailed information about the studies referred above.

Table 1. *A summary of studies on the prevalence of chronic pain*

Study	Sample	Method	Definition of chronic pain	Results
Andersson et al. 1993 Sweden	Population-based study. A random sample from the population register of eastern Sweden. n=1 806 response rate 90% age: 25-74	Questionnaire survey	**> 3 months** **persistent or regularly recurring pain**	55% had perceived persistent pain for 3 months, 49% for 6 months.
Blyth et al. 2001 Australia	Population-based study. Stratified random sample of the residents of New South Wales. n=17 543 response rate 71% age: >15	Telephone interview	**>=3 months** Pain experience **every day for 3 months during the prior six months**.	17% of males and 20% of females reported chronic pain.
Eriksen et al. 2003 Denmark	Population-based study. National random sample. n=10 066 response rate 60% age: >16	Interview and questionnaire survey	**>= 6 months** "Do you have chronic /long-lasting pain lasting 6 months or more?" Persons with cancer diagnosis were excluded.	Prevalence of chronic pain 19%, (16% for men and 21% for women).
Mäntyselkä et al. 2003 Finland	Population-based study. Stratified national random sample. n=6 500 response rate 71% age: 15-74	Questionnaire survey	**>= 3 months** duration of at least 3 months, additional questions about frequency: at most once a week, several times a week, daily or continuously	Prevalence of chronic pain was 35%, daily chronic pain 14%.
Rustøen et al. 2004a Norway	Population-based study. National random sample. n=1 912 response rate 49% age:19-81	Questionnaire survey	**>3 months** "Do you generally have pain?" "When the pain started?" (year, month, day)	28% had pain, 24% had chronic pain.

Breivik et al. 2006 15 European countries and Israel	Population-based study. Stratified national random samples. n=46 394 response rate 54% Screening interviews identified >= 18 yrs with chronic pain for in-depth interviews n=4 839, response rate 97% Age: >17	Telephone interview, in-depth interviews	**>=6 months**, had experienced **pain in the last month**, experienced **pain at least two times per week** and **rated their pain intensity** when they last experienced pain **as at least 5 on a 10-point numeric rating scale**.	19% had moderate or severe chronic pain.
Gureje et al. 1998 15 health centres in 14 countries of Asia, Africa, Europe and Americas	Patients attending the participating primary care facilities. n=25 916 response rate 96% Of 8729 patients 5447 were interviewed (response rate 62%). Health centres were selected based on previous successful collaboration with WHO. Sample stratified according to GHQ scores. Sampling scheme was weighted. Age: 18 or age of majority – 65	Interviews	**>= 6 months** **Current and persistent pain present most of the time for a period of 6 months or more during the prior year.** Additional criteria: patients needed to report that at some time during their lifetime they had talked to either a physician or a health professional about their pain, had taken medication for the pain more than once, or had reported that the pain had interfered with their life or activities a lot.	Prevalence of pain varied from 6% (Nigeria) to 33% (Chile). Mean prevalence was 21.5%.

Two recent attempts have been made to produce large-scale information on pain prevalence covering several countries. Breivik et al. (2006) focused on the prevalence of pain in Europe. Their study included 15 European countries and Israel and was based on random sampling across the population of each country. The average prevalence of moderate or severe chronic pain was 19 per cent, although there was some variation between the countries (from 12% to 30%). The prevalence in Finland and its neighbouring country Sweden was 19 and 18 per cent, respectively. Unfortunately, the large differences in response rates (38-80%) hamper the validity of the results. Nevertheless, the study was still a noteworthy effort to scan the prevalence of chronic pain across European populations.

Secondly, the World Health Organization study focused on the prevalence of chronic pain in Asia, Africa, America and Europe (Gureje et al. 1998). The study population comprised primary care attendees at 15 health centres in 15 cities.

Stratification was made by General Health Questionnaire (GHQ) scores. The average prevalence of pain was 22 per cent, but varied by country from six to 33 per cent. The variation within the European cities was from 12 to 26 per cent. The lowest prevalence was found in Africa and the highest in South America, which probably reflects cultural differences in expressing pain and seeking care accordingly. The mean prevalence rate of 22 per cent reported in this study is close to that of the European study (19%), even though the pain criteria differed to some extent and the sampling methods differed radically: all the participating health centres in the WHO study were located in big cities and convenience sampling was used based on previous successful WHO collaboration. Thus, the results should be interpreted with caution and do not directly represent pain prevalence in the participating countries.

Persistence of pain, incidence and recovery rates

Pain is a quite persistent problem. According to a Finnish study, 20 per cent of patients visiting primary care doctors due to pain reported chronic pain lasting over six months (Mäntyselkä et al. 2001). In the European pain study (Breivik et al. 2006) 60 per cent of respondents with chronic pain reported persistence of between two and 15 years, and a longitudinal study conducted in Sweden (Andersson et al. 2004) reported that 85 per cent of those with initial chronic pain still reported pain 12 years later. Moreover, recovery rates from chronic pain are low: the annual recovery rate reported in a Danish study (Eriksen et al. 2004) was 8.7 per cent, but only 5.4 per cent in a Scottish study (Elliott et al. 2002) carried out among primary care attendees. The annual incidence rate was quite low in Denmark at 1.8 per cent, but as high as 8.3 per cent in Scotland.

3.2. Socio-demographic and socio-economic risk groups

The Finnish study on pain found no gender differences in terms of prevalence (Mäntyselkä et al. 2003), which is in contrast to the findings of many studies in which women report pain more often than men (Gureje et al. 1998; Elliott et al. 1999; Blyth et al. 2001; Eriksen et al. 2003; Rustøen et al. 2004a and 2004b).

Pain is more prevalent among older people (Elliott et al. 1999; Blyth et al. 2001; Eriksen et al. 2003; Mäntyselkä et a. 2003). However, the findings of a Swedish study (Andersson et al. 1993) suggest that pain does not increase steadily with age

and that retirement age may be a turning point. Similar results have been found in the UK (Elliott et al. 2002), the incidence being smaller among pensioners than among the other employment groups. Being married or cohabiting is usually considered to be protective in terms of health, but no similar protective effect has been found in pain studies, except in Denmark where an excess rate of chronic pain was found among those who were separated or divorced (Eriksen et al. 2003), later confirmed by a follow-up study (Eriksen et al. 2004). There is no obvious reason why this difference was only found in Denmark, but it gives reason to test whether similar differences exist in the study population of the present study.

Pain is unevenly distributed by socio-economic status. Chronic pain is more common among those with a lower level of education than among the more highly educated (Blyth et al. 2001; Smith et al. 2001; Eriksen et al. 2003; Rustøen et al. 2004a). Socio-economic differences in the prevalence of pain have been investigated quite extensively in a series of studies covering a Scottish sample of general practice attendees. Smith et al. (2001) found an association between the employment situation and pain, but they could not assess the effect of occupational class due to problems in categorizing those outside of working life. There was also an association with housing tenure: being owner-occupiers reported less pain than those in local council rented accommodation (Elliott et al. 1999). A Swedish study (Andersson et al. 1993) reported occupational differences in pain prevalence: farmers, employers and blue-collar workers reported higher rates than white-collar employees. However, the categorization of occupational class was based on trade-union affiliation and education, not on occupation, and those who were retired were categorized based on their affiliation before retirement. According to the previously mentioned Australian study, the unemployed, those receiving disability benefit, and those who are pensioned due to health reasons reported pain more often than employed persons. The above mentioned Scottish study reported similar results. However, there was no corresponding evidence in two Nordic studies (Brattberg et al. 1989; Rustøen et al. 2004a).

3.3 Risk factors

There are several perspectives from which to study risk factors of pain, such as in terms of onset, duration/persistence/severity, and recovery. There has been very little research on work-related risk factors of ‘any pain’. This section of the

literature review therefore focuses on risk factor studies on located or diagnosed pains in association with onset of pain, duration/persistence or severity. Cross-sectional investigations aim at establishing associations between the study factors and pain graded by duration or severity, for example, whereas longitudinal studies potentially allow detection of factors affecting onset or recovery. The limitation of these studies is that they often focus on narrow occupational groups or single occupations. Given the necessarily small variation in risk factors, they are therefore unlikely to reveal much about the risks of pain in working life in general. A further restriction is that, with the emphasis on psychosocial factors, control for physical factors is often neglected. Physical risk factors are typically clustered by occupation, and if they are not controlled for the results about psychosocial risks may not be fully revealed.

Work-related risk factors

Previous studies have shown that multiple factors affect pain among employees. The study of work-related physical risk factors has a long tradition (Punnett and Wegman 2004). Often found physical risk factors include general measures of physical work load such as physically strenuous work, heavy workload and physically demanding work (Foppa and Noach 1996; Bildt Thorbrjönsson 2000; National Research Council 2001; Miranda et al. 2002), and ergonomic factors such as awkward postures, rotation, vibration, flexing, the lifting of heavy loads, monotonous work and repetitive work (Bildt Thorbjörnsson et al. 2000; van der Windt et al. 2000; Ariens et al.2002; Cassou et al, 2002; Hoogendoorn et al. 2002; Miranda et al. 2002). Manual materials handling, and frequent bending and twisting are risk factors for musculoskeletal pain (National Research Council 2001). However, physical factors play an increasingly smaller role in current working life. Moreover, they explain only part of the pain problem and represent only one aspect of the work environment. The study of risk factors has therefore expanded to include the psychosocial work environment, which may have an impact on the perception, emergence and/or persistence of pain (Estlander 2003), although evidence is still scant. New findings point towards common effects of the psychosocial work environment on pain complaints across anatomical sites (Nahit et al. 2003), which underlines the need for risk factor studies on pain in general.

The typical focus of studies on the work-related psychosocial risk factors of pain has been on Karasek's demand-control or demand-control-support model. Many of them have shown that job strain or its components, i.e. job control and job

demands, are related to pain (Foppa and Noack 1996; Amick et al. 1998; Nahit et al. 2001; Kopec and Sayre 2004; Östergren et al. 2005; Leroux et al. 2006) (see Table 2). Strong associations have also been found between low social support from co-workers or supervisors and pain outcomes (Leino and Hänninen 1995; Ariens et al. 2001; Hoogendoorn et al. 2000 and 2001; Nahit et al. 2003). Complementing the conventional dimensions of Karasek's model, low job satisfaction has also been associated with pain (Hoogendoorn et al. 2000; Nahit et al. 2001; Nahit et al. 2003; Kopec and Sayre 2004). A recent summary review of the associations between work-related psychosocial factors and musculoskeletal pain suggest that when the reviewing standards are set high the associations with the components of Karasek's model fluctuate a lot (Macfarlane et al. 2009).

A major problem in previous studies on psychosocial work factors is that the psychosocial work environment is restricted to the components of Karasek's model (Amick et al. 1998; Hannan et al. 2005; Östergren et al. 2005; Leroux et al. 2006). This limits the drawing of conclusions about their importance in that other simultaneously present work-related psychosocial factors could also affect the association with pain. Potential psychosocial risk factors outside of Karasek's model include experience of injustice in the organization, bullying at workplace, and problems in combining work and home duties. All of which have been found to be associated with poor health outcomes (Einarsen et al. 1996; Vartia 2001; Elovainio et al. 2002; Kivimäki et al. 2003; Hoel and Faragher 2004; Kivimäki et al. 2004; Väänänen et al. 2004; Elovainio et al. 2006; Winter et al. 2006). Thus, it is possible that these factors also affect the experience of pain, or even the previously found association between job strain with pain, but there is still a lack of research evidence.

Table 2. *Studies on the association of Karasek's model and pain*

Authors	**Pain outcome**	**Studied psychosocial association(s)**	**Found psychosocial association(s)**	**Original Karasek's measure** **yes/no**	**Controlled for work-related physical factors**	**Characteristics of the study method and sample**
Amick et al. 1998	Pain (Bodily Pain subscale from SF-36)	Job strain, iso-strain.	High **job strain**, iso-strain.	yes	yes, one question	Cross-sectional, n=33689, women, nurses, United States
Cole et al. 2001	Back problems (BP), musculoskeletal activity restriction	Job strain, demands, control, social	High **job strain** (women, BP and MAR),	yes	yes, one question	Cross-sectional, n=8273, population sample restricted

	(MAR)	support, job insecurity.	psychological demands (women BP and MAR), high job insecurity MAR), low social support (women MAR).			to working population, Canadian 1994 national population health survey, Canada
Foppa and Noack 1996	Back pain	Job discretion, job demands, job strain, low recognition through work, high competition, low job satisfaction, dissatisfaction with salary, time pressure.	Low job discretion, high job demands, low job satisfaction (men), dissatisfaction with salary (women)	no	only vague information	Cross-sectional, n=850, Berne Workplace Health Project, employees of two medium-sized enterprises, Switzerland
Hannan et al. 2005	Incident symptoms in the neck, shoulder, elbow, forearm, hand, wrist or fingers categorized further as neck /shoulder (NS) and arm/hand (AH)	Job strain.	High **job strain** (NS).	yes	no	Follow-up, n=337, computer users, United States
van den Heuvel et al. 2005	Neck/shoulder symptoms (NS), elbow/wrists/hand symptoms (EWH)	Job demands, skill discretion, decision authority and social support.	High job demands (NS), low social support of co-workers (EWH)	yes	yes, some questions and video recordings	Follow-up, n=787, blue-collar workers, white-collar workers and workers in caring professions. Study on musculoskeletal disorders, absenteeism, stress and health (SMASH), Netherlands
Hoogendoorn et al. 2001	Low back pain	Quantitative job demands, conflicting demands, decision authority, skill discretion, supervisory support, co-worker support.	No statistically significant associations.	yes	yes, some questions and video recordings	Follow-up, n=861, workers from 34 companies, Netherlands
IJzelenberg and Burdorf 2005	Musculoskeletal symptoms	Job demands, job control, job strain.	High **job strain**, low social support from supervisor (low back pain only)	yes	yes, three questions	Follow-up study, n=407, industrial workers, Netherlands
Jablonska et	Pain	Job strain, social	High **job strain**, low social	yes	no	Cross-sectional,

al. 2006		support at work	support			n=3616, general population, Sweden
Kopec and Sayre 2004	Non-specific pain or discomfort	Job satisfaction, total psychological work-related stress (skill discretion, decision authority, psychological demands, job insecurity, social support).	Work-related stress: high psychological demands and low skill discretion.	yes	yes, one question	Longitudinal data, n=6571, randomly chosen sample of population (employed at baseline), National Population Health Survey, Canada
Leroux et al. 2006	Neck and shoulder symptoms	Psychological demands, decision latitude, social support, job strain	Psychological demands, **job strain** (association stronger for those with low social support).	yes	yes, many aspects	Cross-sectional, n=1543, white-collar workers in two large public-service organizations, Canada
Nahit et al. 2001	Regional pain syndromes: low back pain, shoulder pain, wrist/forearm pain, knee pain	Psychological distress, demands (stressful work, hectic work), control, social support, job satisfaction	Psychosocial distress, job demands and low control were associated with pain in multiple sites. High levels of psychological distress were associated with pain in one site.	no	no	Cross-sectional, n=1081, newly employed employees in 12 occupational groups in which high rates of musculoskeletal disorders had previously been identified, United Kingdom
Toomingas et al. 1997	Musculoskeletal symptoms, signs, and syndromes.	Psychological demands, decision latitude, social support, job strain.	Low social support at work, high psychological demands and high **job strain.**	yes	yes, number of questions is unclear	Cross-sectional, n=358, furniture movers (n=83), medical secretaries (n=89), sample of working population (n=186), Sweden
Östergren et al. 2005	Shoulder and neck pain	Job demands, control, job strain and job support.	High **job strain** (women).	yes	yes, 11 questions	Follow-up, n=4919, randomly chosen vocationally active men and women, Sweden.

Behavioural risk factors

There is a lack of research between health behaviours and pain, irrespective of the location. However, of the behavioural risk factors, obesity and smoking have been associated most consistently with located chronic pains such as back pain (Foppa

and Noack 1996; Leino-Arjas 1998; Andersson et al. 1998; Lake et al. 2000; Shiri et al. 2010a and 2010b). It also seems that obesity is associated with disability related to chronic pain (Marcus et al. 2004), and there is evidence that smoking may affect pain intensity (Jacobsson 2008). Alcohol abuse has not been studied as a risk factor with regard to pain. It is possible that people in pain may try seek relief in alcohol, although the association with problem drinking could be both ways: pain may cause the drinking or drinking may worsen the pain problem. According to recent research, sleeping problems may also predict chronic pain (Canivet et al. 2008).

3.4 Consequences of pain

The consequences of pain have been considered from several perspectives, with several outcomes as reviewed in the following.

Chronic pain has multiple consequences on the societal level, but also for the pain sufferer. Human suffering, a lower quality of life, restrictions on daily activities and hobbies, sleep problems and financial drawbacks are typical consequences on the individual level (Becker et al. 1997; Mäntyselkä et al. 2001; Aaron et al. 2002; Marty et al. 2008). It also seems that interference with daily activities due to pain increases heavily with age (Thomas et al. 2004) and it has even been suggested that widespread pain may predict all-cause (Andersson et al. 2004) and cancer (McBeth et al. 2009) mortality. However, findings concerning cancer mortality have not been consistent (Macfarlene et al. 2007). Moreover, new evidence suggests that increased all-cause mortality is associated with lifestyle factors such as sleep problems, smoking and low physical activity (Andersson 2009).

Among the working age population pain decreases work effectiveness, causes sickness absence, and may even force the sufferer out of working life (Blyth et al. 2003; Mäntyselkä et al. 2001; Breivik et al. 2006). According to an Australian study (Blyth et al. 2003) 29 per cent of those with pain reported that their work was restricted because of it. People typically continued to work while in pain, although 60 per cent of those who did so reported a decrease in effectiveness because of it. The researchers concluded that it was normal to work while in pain, and they calculated that over a six month period 84 working days were affected because of pain. Over the same period the number of sickness absence days was 4.5. All in all this is equivalent to an average of 16 lost days. It was reported in a Finnish study that a quarter of pain-related visits to the doctor led to sickness absence

(Mäntyselkä et al. 2001). According to a European study 13 per cent of the employees had had to change their work tasks due to pain and as many as 19 per cent had lost their job (Breivik et al. 2006).

A decrease in work ability may increase the risk of early retirement, but unfortunately there are no statistics available on the association between pain and early retirement. However, the statistics of musculoskeletal diseases in which pain is likely to be the most disabling element gives some clues: these diseases are the leading cause of sickness absence and early retirement in Finland (Järvisalo 2005). A Swedish population-based follow-up study from 1980s and 1990s also gives some indirect evidence of the association suggesting that sickness absence due to musculoskeletal diseases predicts future disability pension (Kivimäki et al. 2007).

Pain and health-related functioning

The Short Form 36 Health Survey (SF-36) has been used to examine the effects of pain on health-related functioning and the quality of life (Bergman et al. 2004; Kerr et al. 2004; Becker at al. 1997) and has been found to be sensitive to changes in pain status and to predict its future development (Elliott et al. 2002; Bergman et al. 2004). Compared to other medical conditions, patients with severe chronic pain are among those with the lowest levels of health-related functioning (Becker et al. 1997).

According to a study on 95 sets of twins in the Netherlands, both widespread pain (pain above and below the waist and in right and left side of the body) and regional pain (pain or pains not meeting the criteria of widespreadness) were associated with lowered physical health-related functioning (Aaron et al. 2002). A Swedish population-based longitudinal study (Bergman et al. 2004) confirmed these results, and also found associations with mental dimensions of functioning. The effect of widespread pain was stronger than the effect of regional pain. It was found in another Swedish population-based study (Andersson et al. 1996) adopting a less strict definition of widespreadness (pain at in least four locations in both the upper and lower parts of the body) that multiple pain sites were associated with higher pain intensity and consequent disability, as well as longer duration than pain restricted to the neck and shoulders. Those with widespread pain also had a worse prognosis in terms of persistence and working capacity.

Roux et al. (2005) studied the effects of musculoskeletal diseases (e.g., back pain, disk herniation, osteoarthritis, capsulitis) on functioning in a follow-up setting in France among 45-60 –year-olds, and a similar study was conducted in the Netherlands among the over-25s (Picavet and Hoeymans 2004). However, whereas the French study focused on musculoskeletal diseases as a group, the Dutch study compared the effects of different diagnoses with SF-36 functioning. Both studies reported a stronger effect on physical functioning than on the mental functioning subscales. The French study also reported a heavier impact of chronic as opposed to acute disorders on physical functioning, vitality, emotional roles and social functioning. It was found in the Dutch study that different diseases were differently associated with functioning: the worst quality of life was associated with osteoarthritis of the hip or knee, osteoporosis, rheumatoid arthritis and fibromyalgia, and multiple musculoskeletal diseases (comorbidity) were associated with the poorest functioning. An Italian population-based survey (Salaffi et al. 2005) concentrating on musculoskeletal conditions also reported differences in SF-36 scores by diagnostic groups (rheumatic diseases, symptomatic peripheral osteoarthritis, low back pain, soft-tissue disorders), and an overall stronger effect on physical functioning than mental.

There is some evidence from a UK general population-based study of older adults (50+) (Thomas et al. 2004) that an increasing number of painful areas (simple count) is associated with increased interference in daily life. However, interference was measured only on one question.

Despite the extensive set of studies described above, there is still a lack of knowledge about the association between pain, unconstrained by requirements of widespreadness and not tied to a certain diagnosis or diagnostic group such as musculoskeletal diseases, and health-related functioning among employees.

Pain and sickness absence

There is a series of studies examining the association between pain and sickness absence, but so far most of them have focused on absence due to specific problems, such as low back (Ariens et al. 2002; Hoogendoorn et al. 2002; Kuijer et al. 2006) or neck and shoulder (Holtermann et al. 2010) pain. In other words pain has been considered part of the sickness absence outcome. Characteristics of pain have been studied in terms of explanatory factors (Morken et al. 2003; Bergström et al. 2007; Holtermann et al. 2010). Severity, a high level of pain and high intensity have been found to be associated with increased sickness absence

(Nilsson et al. 2005; Lötters and Burdorf 2006; Fjell et al. 2007). A study among aluminium-industry workers also reported that widespreadness of pain was a predictor of sickness absence (Morken et al. 2003). The effect of acute as opposed to chronic pain on sickness absence has not been studied.

The approaches in the studies mentioned above does not include direct examination of the effects or burden of pain on sickness absence. Moreover, many of them were carried out in homogenous settings, such as among industrial workers (Morken et al. 2003) or employees in nursing homes (Burdorf and Jansen 2006), which limits the generalizability of the findings. The quality of the information on sickness absence also varies substantially. Some studies used retrospective sickness absence information obtained directly from employees (Nilsson et al. 2005; Ihlebaek et al. 2006), whereas others used high-quality register data (Ariens et al. 2002; Hoogendoorn et al. 2002). Retrospective questionnaire information is prone to recall bias. Nevertheless, longitudinal, register-based studies on the effects of pain on sickness absence are rare. All this restricts understanding of the role of pain in predicting total sickness absence.

Pain and sickness absence share similar determinants including age, gender, occupational class and physically straining work, and some psychosocial factors such as bullying, job strain and social support (Niedhammer et al. 1998; Vahtera et al. 1999; Kivimäki et al. 2000; Picavet and Schouten 2000; Smith et al. 2001; Voss et al. 2001; Allebeck et al. 2004; Vingård et al. 2005; Lund et al. 2006; Nielsen et al. 2006; Bang Christensen et al. 2007). These factors need to be taken into account in studies on the association between pain and sickness absence.

3.5 A Summary of previous research

Studies on prevalence suggest that pain, and especially chronic pain, is common and constitutes a broad and persistent public health problem. However, the picture on population level is still blurred given the varying definitions of chronicity and differences in the selection of the target population as well as in research methods. Furthermore, population-based studies give only a vague estimate of the prevalence of pain among the work force in that they also include those who are excluded from working life for reasons to do with age or sickness, for example. There is thus a shortage of basic prevalence studies on the magnitude of pain problems and the distribution of pain among employees. This

kind of information is needed in order to shed light on the scale of the problem and identify potential high risk groups.

Previous studies on the risk factors of pain among employees have focused only on diagnosed or located pains, such as in the low back or neck. However, we need information on whether there are common risk groups or risk factors for pain in general. Research has rarely focused on socio-economic risk groups and when it has, only single indicators have been used. Studying several indicators simultaneously would give a more comprehensive view. Moreover, whereas physical risks have been subjected to thorough examination, studies on work-related psychosocial risk factors have mainly focused on Karasek's (1985) demand-control model. This model assesses the effects of demands and control related to work tasks, but given that the psychosocial work environment includes a wide variety of other aspects, there is a need for research on a wider variety of psychosocial risk factors. In addition, in order to single out the associations between psychosocial factors and pain, adjustment must be made for physical work factors as well as previously identified health behaviour factors.

There is evidence that pain has a variety of negative consequences. Restrictions on daily activities are common, and the burden on the individual and on the public economy is heavy. Little is known about the effects of pain on different aspects of health-related functioning and on sickness absence rates among employees. Previous studies touching on this issue mainly concern located or widespread pain and there is a lack of research on the effects of pain as a general phenomenon on functioning and sickness absence. Nor is it clear whether there are particular characteristics of pain that are especially detrimental in terms of functioning. Information of the consequences of pain are needed in order to assess the magnitude of its effects on work ability, identify those at risk of a decline in work ability, and plan effective occupational health care.

4. THE CONTEXT AND AIMS OF THE STUDY

This study is part of the ongoing Helsinki Health Study, which focuses on the health and well-being of employees, aged 40 years and over, of the City of Helsinki. The City of Helsinki is the largest municipal employer in Finland with ca. 40 000 employees (72% women). The mean age of employees was 45 years in 2002 (City of Helsinki personnel report 2002). Over 100 occupational titles are represented, the main sectors being social affairs (children's day care, social welfare services, services for the elderly and handicapped, immigration affairs), public health care (municipal health and hospital services), public works and environmental affairs (public transport, municipal engineering and maintenance, environmental affairs, fire and rescue services), cultural and personnel affairs (general and vocational education and training, adult education services, city library services, cultural affairs, sports, youth activities, personnel policies), city planning and real estate (urban and traffic planning, land purchases and transfers, real-estate management, municipal housing – production and repair, building regulations), and the Mayoral sector (general administration, information services and the promotion of tourism, energy supply, the Port of Helsinki: including port services for freight and passenger traffic, water supply and sewage treatment) (City of Helsinki annual report 2007).

The focus of this study is on the factors that are particularly characteristic of employees, work and the work environment. The general objective is to examine pain, especially chronic pain, among middle-aged employees, to identify high-risk groups, to study the work-related psychosocial risk factors, and to examine the consequences of pain for employee work ability and health.

The specific aims are:

To examine the prevalence of acute, chronic and disabling chronic pain among employees by socio-demographic and socio-economic sub-groups and to identify high risk groups. (Sub-study I)

To examine the work-related psychosocial risk factors of acute and chronic pain while simultaneously taking into account physical working conditions and health behaviours. (Sub-study II)

To examine the associations between pain and health-related functioning simultaneously assessing whether the type of pain measure affects these associations. (Sub-study III)

To examine the associations between pain and subsequent sickness absence, and whether work-related factors, including both psychosocial and physical factors, affect this association. (Sub-study IV)

It is assumed on the basis of previous research that work-related factors, health behaviours and socio-economic factors predict pain and that pain predicts health-related functioning and sickness absence. It is nevertheless acknowledged that reverse causality is also possible.

5. DATA AND METHODS

The data set comprises of the Helsinki Health Study cross-sectional baseline survey data and the City of Helsinki personnel register data.

The data on ageing municipal employees provides a good basis for the study of pain among people of working age and the questionnaire survey data with register linkages enables prospective analysis. The range of occupations within the City of Helsinki is large and heterogeneous, which is useful in terms of assessing pain across different occupational groups and, thus, different types of work related exposure. The survey data was limited to people aged 40 years or over, the justification being that ageing employees in particular carry the burden of cumulative exposure to physical and psychosocial risk factors, and therefore provide a basis for research of work-related health problems and the associated risks. Chronic pain, too, is more common in older age groups and has the most severe impact on ageing employees.

5.1 DATA SOURCES

SURVEY DATA

The survey data were collected by mail. Questionnaires were sent to all employees of the City of Helsinki reaching the age of 40, 45, 50, 55 or 60 during the study years 2000, 2001, or 2002. The number of respondents in the final, pooled data was 8 960, and the response rate was 67 per cent. The surveys were carried out following the same method in each year. Information on eligible employees was received from the employer's personnel register. Those on a monthly salary were included in the data, whereas trainees were excluded. The questionnaire was sent to each employee's work place. If it did not reach there it was mailed to the home address. Up to three reminders were sent to non-respondents. The register data were updated at the end of the survey and those who had retired, or died, or who had an income of less than € 4 000/year, or over 300 absence days during the survey year and the previous year were further excluded.

The survey data from year 2000 was excluded for the purposes of the sub-studies II and III. In the case of sub-study II this was because of the differences in the format of the question concerning bodily locations of pain. In 2000 the

respondents were asked to mark the most disturbing pain location, but many of them marked several. The question was therefore reformulated and in the questionnaires of 2001 and 2002 the respondents were asked to mark all the locations in which they felt pain. In sub-study III the reason for omitting the year 2000 was that questions on the work-home interface and organizational justice only appeared on the questionnaire from 2001.

Register data

Permission to use the register data was granted by the personnel manager of the City of Helsinki. Personnel register data were obtained from the City of Helsinki, and contained information on salaries, type of employment contract, job title, leaves of absence, absence due to taking care of a sick child and sickness absence. Data was collected, with the permission of the personnel manager of the City of Helsinki, from the registers by the authorized representative and handed over to the Helsinki Health Study researchers. The register data was linked to the survey data for those who had given permission to do so (78%, N=6 988). The linkages were carried out using the unique personal identification number assigned to all Finnish citizens. Sixteen employees were excluded from the combined data because they had removed the study identification number from the questionnaire, and no register data was available for 38 employees. The final linked data set included 6 934 employees.

5.2 Measures of pain

The respondents were asked whether they were experiencing pain or ache at the moment ("Are you having any pain or ache at the moment?" Yes/ no), and if so when the pain had started ("When did the pain or ache start?" Three months or less/ over three months ago). Pain was defined as acute if it had lasted for a maximum of three months and chronic if it had persisted for more than three months. These definitions follow the recommendation of The International Association for the Study of Pain (IASP 1986). If the response to the first of these questions was negative the respondent was asked to skip the rest of the pain-related questions. Those reporting pain were asked to mark all the bodily locations in which they felt pain ("Where do you have this pain or ache?" Neck or shoulders/ low back/ one or both upper extremities/ one or both lower extremities/ head and facial area/ abdominal area/ somewhere else). If the respondent selected the option "somewhere else" s/he was asked to specify the

location. The measure entitled 'number of locations' is the simple count of reported pain locations for each respondent.

Disabling chronic pain was measured on the disability subscale of Von Korff's Chronic Pain Grade questionnaire (CPG) (Von Korff et al. 1992). The CPG measures disability during the previous six months affecting daily activities, work, housework, leisure time, and social and family activities. The specific questions were: 1) "In the past 6 months, how much has pain interfered with your daily activities rated on a 0-10 scale where 0 is 'no interference' and 10 is 'unable to carry on any activities'?", 2) "In the past 6 months, how much has pain changed your ability to work where 0 is 'no change' and 10 is 'extreme change'?", 3) "In the past 6 months, how much has pain changed your ability to take part in recreational, social and family activities where 0 is 'no change' and 10 is 'extreme change'?", 4) "About how many days in the last 6 months have you been kept from your usual activities (paid work, housework or studies) because of pain?" (response categories: 0-6 days/ 7-14 days/ 15-30 days/ more than 30 days). The disability index was calculated only for those reporting chronic pain. The scaling followed Von Korff's (1992) instructions. The cut-off point for disabling chronic pain was set between scores two and three on the scale, which ranges from zero to six. Zero indicates no pain, scores of 1-2 indicate low disability and scores of 3-6 high disability that is moderately or severely limiting. In this study the third category is labelled disabling chronic pain, a sub-group of chronic pain. The Cronbach's alpha for the disability subscale was 0.86.

5.3 Risk group and risk factor measures

5.3.1 Socio-demographic and socio-economic risk groups

Socio-demographic risk factors included age (40, 45, 50, 55 and 60 years), gender, and marital status (married/cohabiting, never married, and separated/divorced or widowed).

The socio-economic framework in sub-study I included four measures of socio-economic status. Information on occupational class (managers and/or professionals, semi-professionals, routine non-manual employees and manual workers) was obtained from the register if the respondent had given permission for register linkage, otherwise it was obtained from the survey (Lahelma et al.

2005). Information on education (higher >12 years, secondary 10-12 years or basic <10 years), housing tenure (owner-occupier and renter or another), and income was obtained from the survey. Income was calculated as follows: the respondents were asked to estimate the monthly net income of their household including social benefits but excluding taxes. Following OECD guidelines for the calculation of household income, the first adult household member was given the weight of 1.0, other adults the weight of 0.7, and each child 0.5. The final sum was further divided into quartiles. Socio-demographic and socio-economic factors were used to identify high risk groups in sub-study I and for adjustment purposes in the other sub-studies.

5.3.2 Work-related psychosocial risk factors

The questionnaire survey was used to assess a variety of psychosocial work environment factors. The measures were job strain (Karasek 1979), organizational justice (Moorman 1991; Kivimäki et. al 2003), workplace bullying, work-home interface (Grzywacz and Marks 2000) and social support (Sarason et al. 1987), all of which played a key role in sub-study II. Karasek's job strain questionnaire is a widely used, validated measure, but the measures of organizational justice and the work-home interface are relatively new in the field of health research and pain research especially. Additional tests were performed on these two measures in order to ensure their construct validity.

Job strain

Work-related stress was assessed on Karasek's measure of job strain (Karasek 1979). This measure comprises two dimensions, job demands and job control, both of which affect the stress experience. High demands such as time pressure, a fast working pace and role conflicts, may induce stress, whereas the amount of control over work, in other words one's freedom to organize it in accordance with the demands, can alleviate the stress response.

In order to measure job demands the respondents were asked to rate the following five statements on a scale from strongly agree to strongly disagree: "My job requires working very fast", "My job requires me to work very hard", "I am not asked to do an excessive amount of work", "I have enough time to get the job done", "I am free from conflicting demands that others make" (Cronbach's alpha 0.71). The statements constituting the job control dimension were "My job allows

me to make a lot of decisions on my own", "In my job, I have very little freedom to decide how I do my work", "I have a lot of say about what happens in my job", "My job requires me to learn new things", "My job involves a lot of repetitive work", "My job requires me to be creative", "My job requires a high level of skill", "I get to do a variety of different things in my job", "I have the opportunity to develop my own special abilities" (Cronbach's alpha 0.82).

The scales were weighted according to a scale construction system devised by Karasek (1985). Both dimensions were dichotomized by the median and combined in a two-by-two table: low job strain (high control, low demands), active job (high control, high demands), passive job (low control, low demands), and high job strain (low control, high demands). According to the strain hypothesis, having low job strain i.e. reporting low demands and high control at work is least detrimental to health and this was used as the reference category in the analyses. The category with high demands and high control represents an active job in which work motivation, learning and development are expected to be high. Low demands and low control categorize a passive job in which work motivation is low and there is no need for learning or development. The category assumed to be the most harmful in terms of health is high job strain: high demands and low control at work.

Organizational justice

Organizational justice was measured on Moorman's scale, which includes two dimensions: relational and procedural justice (Moorman 1991; Kivimäki et al. 2003). Relational justice, i.e. the fairness of the conduct of the supervisor, was measured on four items: "Your supervisor…" 1) "considers your viewpoint", 2) "is able to suppress personal biases", 3) "treats you with kindness and consideration", 4) "takes steps to deal with you in a truthful manner". Procedural justice, i.e. the fairness of the decision-making process in the organization, also includes four items: "Procedures are designed…" 1) "to hear the concerns of all those affected by the decision", 2) "to collect accurate information necessary for making decisions", 3) "to provide opportunities to appeal or challenge the decision", 4) "to generate standards so that decisions can be made with consistency". The response categories varied from strongly agree to strongly disagree. The construct validity of the measure in this data was assessed by means of principal component analysis (PCA). In contrast to preliminary assumptions, PCA gave a one component solution instead of two component solution, and

furthermore the correlation between the two scales was 0.7. On account of the one component solution from PCA and the high correlation, the scales were combined in one overall measure of organizational justice (Cronbach's alpha 0.91). The sum of the scales was divided into quartiles. The dimensionality of the organizational justice scale has evoked discussion (Colquitt et al. 2001). Mansour-Cole and Scott (1998) for example used the combined scale. It is hypothesized that low organizational justice is associated with poor health.

Workplace bullying

Bullying was defined in the questionnaire as "With psychological harassment or workplace bullying we mean social isolation of a member of a work community, underestimation of work performance, threatening behaviour, talking behind one's back or other forms of pressure" (Lehto and Sutela 2004; Kivimäki et al. 2000). The respondents were then asked whether this kind of behaviour occurred in their work unit or department. The response categories were: never, sometimes, repeatedly and don't know. Workplace bullying reflects the social climate at work.

Work-home interface

Grzywacz's work-home interface scale was used to measure conflicts between paid work and family life (Grzywacz and Marks 2000). The respondents were asked to what extent their job responsibilities interfered with their family life and how much family life and responsibilities interfered with their work, the response alternatives being: not at all, to some extent, a great deal and I have no family. The statements on the work-to-family dimension were: (1) "your job reduces the amount of time you can spend with your family", (2) "problems at work make you irritable at home", (3) "your work involves a lot of travelling", and (4) "your job takes up so much energy that you don't feel up to doing things that need attention at home", and on the family-to-work dimension: (1) "family matters reduce the time you can devote to your job", (2) "family worries or problems distract you from your work", (3) "family activities stop you getting the sufficient amount of sleep", and (4) "family obligations reduce the time you have for relaxation or being by yourself". Those who reported having no family were included in the analyses in a separate category in order to avoid unnecessary data reduction and distortion on the distribution of married and never married respondents. PCA was used to test the construct validity of the predefined scales.

The statement “your work involves a lot of travelling” did not load onto the work-to-family conflicts scale and had low communality (0.18) and was therefore excluded from the scale. The final PCA produced a two component solution. The work-to-family component included three items (Cronbach’s alpha 0.65), and the family-to-work component four items (Cronbach’s alpha 0.75). A sum was calculated for both scales, and was further divided into three categories following the original categories: no disadvantage, some disadvantage, great disadvantage. Great disadvantage due to work-to-family or family-to-work conflicts is considered detrimental to health.

Social support

The perceived availability of social support was assessed on Sarason’s brief inventory (Sarason et al. 1987). The measure assesses the possibility of receiving social support from one’s spouse/partner, next of kin, a close friend, close workmate or supervisor, a close neighbour, someone else who is close, or nobody, in four possible situations. It was possible to choose one or more options for each situation, and the chosen options were summed up across the scale. The sum score was further divided into tertiles. A low score indicates low social support which is considered to be detrimental to health whereas high support is considered to be advantageous. It should be mentioned that this measure is not restricted to the work environment.

Work-related physical risk factors

Physical risk factors were not the main focus of the study, but they were used in sub-studies II and IV for adjustment purposes. Work-related physical factors were measured on an inventory comprising 18 questions adapted from the Finnish Institute of Occupational Health (Piirainen et al. 2000). The questions were compressed into four components by means of principal component analysis (PCA). The first component was labelled ‘physically strenuous work’ and included four items: awkward postures, rotation of the back, repetitive movements, and heavy physical effort required for lifting heavy loads (Cronbach’s alpha 0.79). Component two was labelled ‘office work’ and it included three items: sitting, working at a computer display terminal and using a computer mouse (Cronbach’s alpha 0.84). Component three labelled ‘working in an upright position’ included two items: standing and walking (Cronbach’s alpha 0.81). Finally, component four included nine items and was called ‘physical-chemical exposure’: noise, vibration,

weak or distracting lighting, solvents, gases or irritant substances, heat, chilliness, draft or changes of temperature, dryness of the air, dust and dirtiness, humidity and wetness, and mould (Cronbach's alpha 0.75).

Health behaviours

Health behaviours were adjusted for in sub-study III. The body mass index (BMI (kg/m^2) <24.9 normal weight, 25.0-29.9 overweight, 30.0-34.9 obesity, >34.9 severe obesity) was used to adjust for the effect of weight on pain. Frequency of consumption (seldom, 1-2 times/month, 1-2 times/week, daily or almost daily) was used to adjust for alcohol intake, and current regular smoking (yes/no) to adjust for the effect of smoking.

5.4 Measures of the consequences

The consequences of pain were measured from two different angles: health-related functioning and sickness absence. The SF-36 served as a measure of health-related functioning and sickness absence as a measure of work ability. These issues are likely to be overlapping to some extent.

Health-related functioning

The Finnish translation of the Short Form 36 Health Survey (SF-36) (Ware and Sherbourne 1992; Hagman et al. 1996) was used to measure health-related functioning. SF-36 is a well validated generic health measure comprising eight subscales: 1) physical functioning (PF), 2) role limitations due to physical health problems (RP), 3) bodily pain (BP), 4) general health perceptions (GH), 5) general mental health (GM), 6) role limitations due to emotional problems (RE), 7) social functioning (SF), and 8) vitality (VI). PF measures the ability to perform physical activities (such as climbing stairs, bathing and dressing, walking shorter or longer distances, lifting and carrying groceries and lifting heavy goods); RP assesses the physical ability to perform work or other daily activities; BP assesses pain-related limitations in the ability to work or to engage in other daily activities; GH is based on comparison with others in terms of one's health and expectations on future health, GM measures states of mind such as nervousness, depression, happiness and peacefulness; RE focuses on limitations in the ability to carry out work and daily activities associated with emotional problems; SF assesses the ability to engage in normal social activities; finally VI assesses the feelings of energy and

fatigue, i.e. subjective well-being (Ware and Sherbourne 1992). GM, RE, SF, and VI are included in the mental domain of health, and PF, RP, BP and GH in the physical domain (Ware 2000). The questions focus on the preceding four weeks.

Sickness absence

Prospective information on sickness absence was obtained from the personnel registers of the City of Helsinki and covered both self-certified (1-3 days) and medically certified (over 3 days) absence. Data on absence days was also available, but the main outcome in sub-study IV was the number of sickness absence spells. This selection was based on the assumption that those with very long sickness absence spells would have dominated the analyses if the number of days had been used. The number of spells was divided into three categories: 1-3 day spells, 4-14 day spells, and over 14 day spells. Consecutive spells were combined if there were no intervening workdays. Absence due to reasons other than the employee's own sickness was excluded from the variable.

5.5 A Summary of the variables used in sub-studies I-IV

Table 3 lists the variables used in each sub-study. Separate analyses were conducted for women and men in each sub-study.

Table 3. *A summary of the study variables*

Sub-study	Outcome(s)	Pain variables if not an outcome	Other variables
I	1) Acute pain (no pain, acute pain) 2) Chronic pain (no pain, chronic pain) 3) Disabling chronic pain (no pain, disabling chronic pain) Outcomes: binomial. Reference group in the analyses: no pain.		Age, marital status, education, occupational class, income, housing tenure.
II	1) Three-category pain variable: no pain, acute pain, chronic pain Outcome: multinomial. Reference group in the analyses: no pain.		Age, education, physical working conditions, body mass index (BMI), smoking, alcohol consumption, job strain, organizational justice, workplace bullying, work-home interface.
III	SF-36 subscales (8) Outcome: continuous.	1)) Bodily locations of pain (8 categories) 2) Number of painful locations (0, 1, 2-3, 4+) 3) Three-category pain variable: no pain, acute pain, chronic pain	Age, marital status, education.
IV	Self-certified (1-3 days) and medically certified (medium length 4-14 days, and long > 14 days) sickness absence spells. Outcomes: continuous.	1) Three-category pain variable: no pain, acute pain, chronic pain	Age, occupational class, job strain, bullying at the workplace, social support, physical work factors.

5.6 Statistical methods

The statistical programs SPSS and SAS were used for the analyses. Table 3 lists the variables included in each sub-study.

The age adjusted prevalence rates and their 95-per-cent confidence intervals were used for descriptive purposes in sub-study I. Given the binary nature of the pain outcomes, logistic regression analysis was used to assess the relative differences in the risk factors analyses, and for adjustment purposes. Those with no pain were used as the reference group in the analyses. The results were presented as odds ratios and their 95-per-cent confidence intervals. The analyses were carried out in

two stages: the first involved the calculation of age adjusted odds ratios with their 95-per-cent confidence intervals for each study variable, and the second, the calculation of the odds ratios adjusted simultaneously for all the study variables.

The prevalence rates, the chi^2-test values and the related p-values were used for descriptive purposes in sub-study II. A three category pain outcome was created to allow comparison between no pain, acute pain and chronic pain in association with the psychosocial factors. This outcome required multinomial logistic regression analysis. The analyses were calculated in two stages: first each psychosocial variable was adjusted for confounders (adjusted own effect), and secondly the psychosocial factors were adjusted for confounders and each other (fully adjusted model). An additional analysis was carried out for this thesis summary in order to shed more light on the association between job strain and pain. The confounders and all the other psychosocial variables were adjusted for one by one, and the results presented as odds ratios and their 95-per-cent confidence intervals. P-values were added to provide an additional measure of statistical significance, and Nagelkerke's pseudo R^2 values provided an approximation of the goodness-of-fit of the logistic models (in the sub-study II only). Tests were conducted in order to assess possible interaction and multicollinearity between the psychosocial variables.

Sub-study III had continuous outcomes (eight SF-36 subscales ranging from zero to 100). Pain measures were used as independent variables, and analysis of covariance was used to assess the associations between pain and the SF-36 dimensions of functioning and to adjust for covariates. The analysis provided means for each SF-36 subscale. In addition, t-tests were used to assess the statistical significance of the differences in the SF-36 subscale mean scores between the pain groups, and effect sizes in order to calculate estimates of the magnitude of the differences. Effect sizes were calculated by dividing the difference of the mean scores of the two groups by the pooled standard deviation. The magnitude of the difference was considered trivial with effect size values from zero to 0.19, as small with values from 0.20 to 0.49, medium from 0.50 to 0.79, and large with values of over 0.80 (Cohen 1988).

The outcome of sub-study IV comprised counts of sickness absence spells of different length (1-3 day spells, 4-14 day spells, and over 14 day spells). Due to overdispersion, negative binomial regression analysis was used for the count data. This is a standard method for modelling overdispersed Poisson data, the purpose here being to calculate the differences in rate ratios between the pain groups and

to adjust for confounders. Follow-up time (person-years) started when the questionnaire was returned and was restricted to three years. If the employment contract was terminated before this, the follow-up ended at that point. The burden of pain on sickness absence was calculated in the form of aetiological fractions (AF) (Hanley 2001) according to the following formula:

Example for AF of chronic pain

*(RR chronic pain -1) * (percentage of those with chronic pain in the total sample) / (1+(RR chronic pain-1) * (percentage of chronic pain) + (RR acute pain – 1) * (percentage of acute pain))*

The aetiological fraction gives an estimate of the amount of sickness absence that could theoretically be avoided if the exposure (pain) could be removed.

5.7 Ethical considerations

The protocol of the Helsinki Health Study has been approved by the Ethical Committees of the Health Authorities at the City of Helsinki and the Department of Public Health, University of Helsinki. The gathering and processing of the data follow the Finnish legislation on data/privacy protection (Personal Data Act, http://www.tietosuoja.fi/uploads/hopxtvf.HTM). Special attention was paid during the data processing to protecting the identity of the respondents, i.e. ensuring that no one could be identified from the results.

6. Results

This chapter summarizes the main results of the sub-studies. The first two sections contains the prevalence rates, risk groups and risk factors, and the third reports the findings on the consequences of pain on health-related functioning and on sickness absence.

6.1 The Prevalence of pain and socio-demographic and socio-economic risk groups

Sub-study I examined the prevalence of pain among employees. A broad set of measures was used to identify socio-demographic and socio-economic risk groups.

It was found that pain was common among employees: 15 per cent of the women and 12 per cent of the men reported having acute pain, 29 per cent of the women and 24 per cent of the men reported chronic pain, and seven per cent of the women and five per cent of the men had disabling chronic pain.

Logistic regression analysis was used to study the associations of pain with the socio-demographic and socio-economic variables. Among the women, following mutual adjustment for all the variables in the study, the older employees were more likely to report chronic or disabling chronic pain than the younger ones (see sub-study I Table 2). The association was the opposite for acute pain which was more prevalent among the younger. Similar results were found among the men, except that the findings concerning disabling chronic pain were not statistically significant (see sub-study I Table 3). Acute pain was more common among the men who were separated/ divorced or widowed than among those who were married or cohabiting. No similar associations were found among the women.

Following adjustment for age only, education, occupational class, income and housing tenure were all associated with chronic and disabling chronic pain among the women (Table 4), and all but housing tenure were associated with acute pain. None of the socio-economic variables were associated with acute pain among the men, but all were associated with chronic pain and all but housing tenure with disabling chronic pain (Table 5).

Table 4. *Age adjusted and fully adjusted[1] odds ratios (OR) from the logistic regression analyses and their 95% confidence intervals (CI) for acute, chronic and disabling chronic pain[2] by socio-economic indicators: women.*

	Acute pain		Chronic pain		Disabling chronic pain[2]	
	Age adjusted OR (CI)	Fully adjusted[1] OR (CI)	Age adjusted OR (CI)	Fully adjusted[1] OR (CI)	Age adjusted OR (CI)	Fully adjusted[1] OR (CI)
Level of education						
Higher	1.00	1.00	1.00	1.00	1.00	1.00
Secondary	1.26 (1.04-1.51)	1.10 (0.85-1.44)	1.26 (1.08-1.46)	1.26 (1.02-1.57)	1.60 (1.15-2.23)	1.21 (0.75-1.95)
Basic	1.46 (1.22-1.74)	1.29 (0.95-1.75)	1.62 (1.41-1.86)	1.55 (1.21-1.99)	3.69 (2.76-4.92)	2.27 (1.36-3.80)
Occupational class						
Managers	1.00	1.00	1.00	1.00	1.00	1.00
Professionals	1.07 (0.77-1.49)	1.14 (0.81-1.62)	1.06 (0.82-1.36)	1.14 (0.87-1.49)	1.79 (0.90-3.56)	1.93 (0.94-3.96)
Semi-professionals	1.37 (0.98-1.90)	1.30 (0.92-1.83)	1.23 (0.96-1.59)	1.09 (0.83-1.43)	2.90 (1.46-5.76)	2.36 (1.16-4.80)
Routine non-manual employees	1.55 (1.14-2.11)	1.35 (0.95-1.93)	1.48 (1.17-1.87)	1.14 (0.87-1.51)	5.12 (2.68-9.78)	2.88 (1.42-5.82)
Manual workers	1.49 (1.05-2.12)	1.28 (0.85-1.93)	1.65 (1.27-2.16)	1.20 (0.87-1.65)	6.40 (3.26-12.54)	3.22 (1.53-6.77)
Income						
1 quartile (highest)	1.00	1.00	1.00	1.00	1.00	1.00
2 quartile	1.08 (0.88-1.32)	1.05 (0.85-1.29)	1.09 (0.93-1.27)	1.02 (0.86-1.20)	1.24 (0.94-1.65)	0.97 (0.72-1.32)
3 quartile	1.07 (0.87-1.31)	0.97 (0.78-1.20)	1.19 (1.02-1.39)	1.07 (0.90-1.26)	1.82 (1.39-2.39)	1.29 (0.96-1.73)
4 quartile (lowest)	1.26 (1.03-1.55)	1.09 (0.87-1.36)	1.26 (1.07-1.48)	1.09 (0.92-1.30)	1.65 (1.24-2.19)	1.01 (0.74-1.38)
Housing tenure						
Owner-occupier	1.00	1.00	1.00	1.00	1.00	1.00
Renter (or other)	1.13 (0.98-1.31)	1.05 (0.89-1.22)	1.14 (1.02-1.28)	1.06 (0.93-1.20)	1.46 (1.20-1.78)	1.05 (0.84-1.31)

[1]Adjusted for age, marital status, education, occupational class, income and housing tenure
[2]Disabling chronic pain indicates chronic pain with high disability and moderate or severe limitations, and is a subgroup of chronic pain

Table 5. *Age adjusted and fully adjusted[1] odds ratios (OR) from the logistic regression analyses and their 95% confidence intervals (CI) for acute, chronic and disabling chronic pain[2] by socio-economic indicators: men.*

	Acute pain		Chronic pain		Disabling chronic pain[2]	
	Age adjusted OR (CI)	Fully adjusted[1] OR (CI)	Age adjusted OR (CI)	Fully adjusted[1] OR (CI)	Age adjusted OR (CI)	Fully adjusted[1] OR (CI)
Level of education						
Higher	1.00	1.00	1.00	1.00	1.00	1.00
Secondary	1.10 (0.74-1.61)	1.07 (0.67-1.71)	1.42 (1.04-1.94)	1.23 (0.85-1.79)	0.96 (0.45-2.07)	0.77 (0.31-1.94)
Basic	1.32 (0.93-1.88)	1.13 (0.65-1.97)	2.09 (1.59-2.75)	1.41 (0.91-2.19)	3.95 (2.24-6.95)	2.42 (0.96-6.12)
Occupational class						
Managers	1.00	1.00	1.00	1.00	1.00	1.00
Professionals	1.10 (0.67-1.78)	1.14 (0.69-1.88)	1.21 (0.82-1.78)	1.24 (0.84-1.85)	1.08 (0.43-2.70)	1.14 (0.44-2.90)
Semi-professionals	1.23 (0.74-2.06)	1.17 (0.66-2.08)	1.65 (1.11-2.45)	1.40 (0.89-2.18)	2.62 (1.12-6.09)	1.63 (0.62-4.30)
Routine non-manual employees	1.18 (0.65-2.17)	1.10 (0.55-2.20)	1.62 (1.01-2.59)	1.27 (0.73-2.22)	3.12 (1.23-7.94)	1.60 (0.54-4.76)
Manual workers	1.50 (0.93-2.43)	1.31 (0.70-2.46)	2.64 (1.83-3.80)	1.92 (1.18-3.13)	4.48 (2.04-9.86)	1.73 (0.64-4.68)
Income						
1 quartile (highest)	1.00	1.00	1.00	1.00	1.00	1.00
2 quartile	1.02 (0.65-1.58)	0.98 (0.63-1.54)	1.15 (0.82-1.60)	0.99 (0.70-1.40)	1.28 (0.64-2.55)	0.97 (0.48-1.98)
3 quartile	1.15 (0.74-1.79)	1.17 (0.73-1.87)	1.61 (1.16-2.23)	1.39 (0.98-1.98)	1.77 (0.91-3.46)	1.31 (0.64-2.67)
4 quartile (lowest)	1.22 (0.79-1.87)	1.06 (0.67-1.70)	1.45 (1.04-2.02)	1.01 (0.70-1.46)	2.65 (1.41-5.00)	1.49 (0.76-2.94)
Housing tenure						
Owner-occupier	1.00	1.00	1.00	1.00	1.00	1.00
Renter (or other)	1.12 (0.81-1.54)	0.99 (0.69-1.42)	1.33 (1.04-1.69)	1.16 (0.88-1.53)	1.52 (0.97-2.38)	1.26 (0.76-2.08)

[1]Adjusted for age, marital status, education, occupational class, income and housing tenure
[2]Disabling chronic pain indicates chronic pain with high disability and moderate or severe limitations, and is a subgroup of chronic pain

Further logistic regression analyses showed that when adjusted for each other (the fully adjusted models in Tables 4 and 5) none of the socio-economic variables remained associated with acute pain among the women or the men. However, the women with a low level of education appeared to be at excess risk of chronic and disabling chronic pain. Moreover employees in all other occupational classes were more likely than managers to report disabling chronic pain. The only statistically significant association among the men concerned chronic pain, which the manual workers were twice as likely to report as the managers. Income, and especially housing tenure, proved to be weak predictors of pain when education and occupational class were taken into account.

The analyses revealed clear socio-economic gradients among the women. The findings were similar, but somewhat less consistent, among the men.

6.2 Work-related psychosocial risk factors

Sub-study II concerned the association of a wide range of psychosocial factors including job strain, organizational justice, workplace bullying and the work-home interface (work-to-family conflicts and family-to-work conflicts) with acute and chronic pain, the aim being to find out whether the association between job strain and pain is affected by other psychosocial factors and whether the other psychosocial factors are associated with pain.

The first step was to study the association between job strain and pain. Multinomial logistic regression analysis revealed an association among the women with both acute and chronic pain following adjustment for confounders (age, education, body mass index, frequency of alcohol consumption, smoking and physical work factors), or confounders and any single psychosocial variable (organizational justice, workplace bullying, work-to-family conflicts, and family-to-work conflicts) (Table 6). When adjusted for confounders and all psychosocial variables simultaneously the association attenuated, but remained statistically significant: those with high strain jobs were more likely to report pain than those with low strain jobs. Job strain was not associated with acute pain among the men, but similar results concerning chronic pain emerged as among the women (Table 7).

Table 6. *Associations of job strain with acute and chronic pain among the women: multinomial logistic regression analyses, odds ratios (OR) and 95% confidence intervals (CI)*

Women	Adjusted own effect [a] OR (CI)	Adj. own effect +organizational justice OR (CI)	Ajd. own effect +bullying at workplace OR (CI)	Ajd. own effect +work-to-family conflict OR (CI)	Adj. own effect +family-to-work conflicts OR (CI)	Fully adjusted model [b] OR (CI)
			Acute pain			
Job strain						
Low strain	1.00	1.00	1.00	1.00	1.00	1.00
Active	1.17 (0.91-1.51)	1.15 (0.89-1.49)	1.14 (0.88-1.47)	1.02 (0.79-1.32)	1.02 (0.79-1.32)	1.00 (0.77-1.30)
Passive	1.14 (0.86-1.50)	1.09 (0.82-1.45)	1.10 (0.83-1.46)	1.11 (0.84-1.47)	1.12 (0.85-1.48)	1.08 (0.81-1.43)
High strain	1.75 (1.36-2.26)	1.65 (1.27-2.16)	1.65 (1.27-2.14)	1.52 (1.16-1.97)	1.69 (1.31-2.18)	1.47 (1.12-1.93)
			Chronic pain			
Job strain						
Low strain	1.00	1.00	1.00	1.00	1.00	1.00
Active	1.38 (1.12-1.70)	1.34 (1.09-1.66)	1.36 (1.10-1.68)	1.14 (0.92-1.41)	1.30 (1.05-1.61)	1.13 (0.90-1.40)
Passive	1.40 (1.12-1.76)	1.34 (1.06-1.69)	1.36 (1.08-1.71)	1.34 (1.07-1.68)	1.37 (1.09-1.72)	1.29 (1.02-1.64)
High strain	2.01 (1.62-2.49)	1.82 (1.46-2.28)	1.92 (1.55-2.39)	1.63 (1.30-2.03)	1.91 (1.54-2.37)	1.55 (1.23-1.95)

[a] adjusted for age, education, body mass index, frequency of alcohol consumption, smoking and physical work factors
[b] adjusted for age, education, body mass index, frequency of alcohol consumption, smoking, physical work factors, job strain, organizational justice, bullying at the workplace, work-to-family conflicts and family-to-work conflicts

Table 7. *Associations of job strain with acute and chronic pain among the men: multinomial logistic regression analyses, odds ratios (OR) and 95% confidence intervals (CI)*

Men	Adjusted own effect [a] OR (CI)	Adj. own effect +organizational justice OR (CI)	Ajd. own effect +bullying at workplace OR (CI)	Ajd. own effect +work-to-family conflict OR (CI)	Adj. own effect +family-to-work conflicts OR (CI)	Fully adjusted model [b] OR (CI)
			Acute pain			
Job strain						
Low strain	1.00	1.00	1.00	1.00	1.00	1.00
Active	1.24 (0.72-2.14)	1.16 (0.67-2.01)	1.28 (0.68-2.39)	1.03 (0.58-1.83)	1.21 (0.70-2.10)	0.93 (0.52-1.66)
Passive	1.39 (0.80-2.42)	1.22 (0.69-2.16)	1.20 (0.68-2.12)	1.32 (0.75-2.32)	1.38 (0.79-2.42)	1.11 (0.61-2.00)
High strain	1.60 (0.87-2.92)	1.34 (0.72-2.51)	1.09 (0.62-1.89)	1.33 (0.71-2.49)	1.56 (0.85-2.88)	1.03 (0.53-2.00)
			Chronic pain			
Job strain						
Low strain	1.00	1.00	1.00	1.00	1.00	1.00
Active	1.63 (1.06-2.52)	1.52 (0.98-2.36)	1.51 (0.97-2.34)	1.48 (0.94-2.33)	1.57 (1.01-2.44)	1.40 (0.88-2.22)
Passive	0.89 (0.55-1.45)	0.79 (0.48-1.31)	0.83 (0.51-1.36)	0.85 (0.52-1.39)	0.84 (0.51-1.38)	0.74 (0.45-1.24)
High strain	2.52 (1.58-4.01)	2.12 (1.31-3.44)	2.22 (1.38-3.58)	2.26 (1.40-3.65)	2.41 (1.51-3.85)	1.94 (1.17-3.22)

[a] adjusted for age, education, body mass index, frequency of alcohol consumption, smoking and physical work factors
[b] adjusted for age, education, body mass index, frequency of alcohol consumption, smoking, physical work factors, job strain, organizational justice, bullying at the workplace, work-to-family conflicts and family-to-work conflicts

The second set of analyses concerned associations of organizational justice, work place bullying and work-to-family conflicts, and family-to-work conflicts with pain. Following adjustment for the confounders only, all of these psychosocial factors were associated with acute and chronic pain among the women (adjusted own

effect, Table 8). The associations with acute pain were weaker than those for chronic pain, except with regard to bullying. Following adjustment for the confounders among the men, organizational injustice, sometimes experiencing bullying at the workplace and experiencing work-to-family conflicts were associated with acute pain (adjusted own effect, Table 9). All the psychosocial variables showed associations with chronic pain.

The association between social support and pain was also tested at this point (data not shown), but in the absence of any association with pain it was left out of the further analyses.

Table 8. *Associations of psychosocial factors with acute and chronic pain among the women: multinomial logistic regression analyses, odds ratios (OR) and 95% confidence intervals (CI)*

Women	**Acute pain**		**Chronic pain**	
	Adjusted own effect [a]	Fully adjusted [b]	Adjusted own effect [a]	Fully adjusted [b]
	OR (CI)	OR (CI)	OR (CI)	OR (CI)
Organizational justice				
1. quartile (a lot)	1.00	1.00	1.00	1.00
2. quartile	1.09 (0.85-1.40)	1.00 (0.78-1.29)	0.93 (0.76-1.13)	0.84 (0.68-1.04)
3. quartile	1.30 (1.01-1.68)	1.09 (0.83-1.42)	1.27 (1.04-1.57)	1.04 (0.84-1.30)
4. quartile (little)	1.37 (1.04-1.79)	0.97 (0.72-1.32)	1.58 (1.27-1.96)	1.15 (0.90-1.47)
Bullying at the workplace				
Not at all	1.00	1.00	1.00	1.00
Sometimes	1.25 (1.03-1.53)	1.12 (0.91-1.38)	1.15 (0.98-1.35)	0.96 (0.81-1.13)
Repeatedly	1.81 (1.30-2.53)	1.49 (1.04-2.15)	1.74 (1.33-2.29)	1.17 (0.87-1.59)
Work-to-family conflicts				
No disadvantage	1.00	1.00	1.00	1.00
Some disadvantage	1.27 (0.97-1.65)	1.13 (0.86-1.48)	1.77 (1.41-2.21)	1.53 (1.21-1.93)
Great disadvantage	1.99 (1.51-2.62)	1.56 (1.14-2.12)	2.79 (2.20-3.53)	2.07 (1.59-2.68)
Family-to-work conflicts				
No disadvantage	1.00	1.00	1.00	1.00
Some disadvantage	1.33 (1.07-1.64)	1.20 (0.96-1.49)	1.51 (1.27-1.80)	1.31 (1.09-1.56)
Great disadvantage	1.71 (1.33-2.20)	1.41 (1.08-1.84)	2.05 (1.66-2.53)	1.62 (1.30-2.03)

[a] adjusted for age, education, body mass index, frequency of alcohol consumption, smoking and physical work factors
[b] adjusted for age, education, body mass index, frequency of alcohol consumption, smoking, physical work factors, job strain, organizational justice, bullying at the workplace, work-to-family conflicts and family-to-work conflicts

Table 9. *Associations of psychosocial factors with acute and chronic pain among the men: multinomial logistic regression analyses, odds ratios (OR) and 95% confidence intervals (CI)*

Men	Acute pain		Chronic pain	
	Adjusted own effect [a] OR (CI)	Fully adjusted [b] OR (CI)	Adjusted own effect [a] OR (CI)	Fully adjusted [b] OR (CI)
Organizational justice				
1. quartile (a lot)	1.00	1.00	1.00	1.00
2. quartile	1.31 (0.72-2.37)	1.04 (0.56-1.94)	1.55 (0.96-2.50)	1.38 (0.84-2.27)
3. quartile	1.78 (0.98-3.23)	1.28 (0.67-2.43)	1.47 (0.89-2.43)	1.22 (0.72-2.08)
4. quartile (little)	1.93 (1.02-3.64)	1.27 (0.62-2.57)	2.63 (1.59-4.34)	2.04 (1.16-3.60)
Bullying at workplace				
Not at all	1.00	1.00	1.00	1.00
Sometimes	2.32 (1.47-3.64)	2.05 (1.28-3.29)	1.78 (1.27-2.50)	1.42 (0.99-2.04)
Repeatedly	1.95 (0.88-4.34)	1.61 (0.67-3.87)	1.98 (1.11-3.52)	1.12 (0.58-2.17)
Work-to-family conflicts				
No disadvantage	1.00	1.00	1.00	1.00
Some disadvantage	1.86 (1.05-3.32)	1.68 (0.91-3.07)	1.78 (1.14-2.78)	1.34 (0.84-2.16)
Great disadvantage	2.21 (1.19-4.10)	1.93 (0.95-3.92)	2.10 (1.30-3.40)	1.20 (0.69-2.08)
Family-to-work conflicts				
No disadvantage	1.00	1.00	1.00	1.00
Some disadvantage	1.07 (0.67-1.72)	0.88 (0.53-1.46)	1.49 (1.03-2.15)	1.37 (0.93-1.86)
Great disadvantage	1.28 (0.74-2.22)	0.99 (0.54-1.80)	1.37 (0.87-2.16)	1.13 (0.69-2.04)

[a] adjusted for age, education, body mass index, frequency of alcohol consumption, smoking and physical work factors
[b] adjusted for age, education, body mass index, frequency of alcohol consumption, smoking, physical work factors, job strain, organizational justice, bullying at the workplace, work-to-family conflicts and family-to-work conflicts

Adjusting for the confounders and all the work-related psychosocial variables (Tables 8 and 9, fully adjusted models) somewhat attenuated all the associations of psychosocial variables with acute and chronic pain. However, even then there remained an association with both pain outcomes on both dimensions of work-home interface among the women. Bullying at the workplace remained associated only with acute pain and organizational justice was not associated with either pain type. Among the men the associations were slightly different: only bullying was associated with acute pain, and organizational justice were associated with chronic pain. The work-home interface was not associated with pain.

6.3 THE CONSEQUENCES OF PAIN

6.3.1 HEALTH-RELATED FUNCTIONING

Sub-study III examined the association between pain and health-related functioning, and whether categorizing pain in different ways, i.e. according to

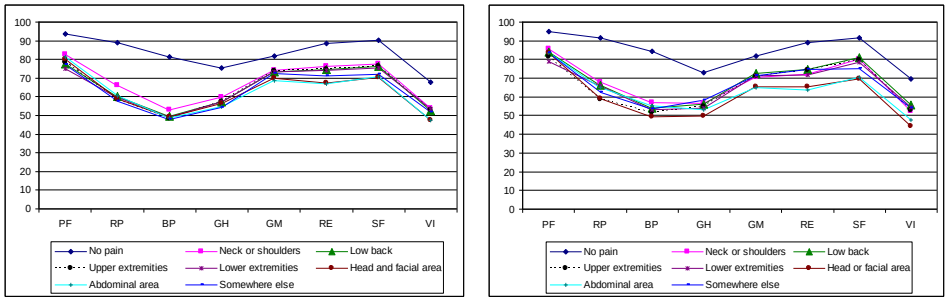
duration (acute, chronic), location, or number of locations would reveal any differences in functioning.

The first step was to study prevalence rates by pain category (see sub-study III Table 1). It was found that the most common locations of pain were in the neck or shoulders (28% among the women and 19% among the men) followed by one or both legs among the women (18%) and low back among the men (16%). Moreover, pain was typically experienced in multiple locations: 62 per cent of the women and 56 per cent of the men reporting pain mentioned two or more locations. Finally, it was shown again, that chronic pain was twice as common as acute pain: 28 vs. 15 per cent among the women and 24 vs. 12 per cent among the men.

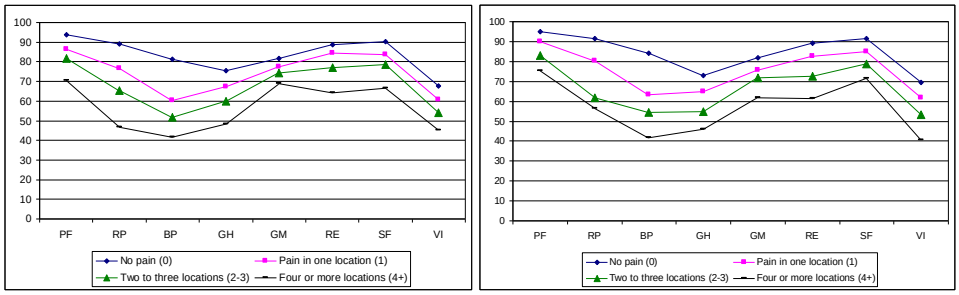
Analysis of covariance was used to provide the mean scores for the SF-36 subscales by pain category and to adjust for the covariates. Overall, it was found that compared to not having pain, having pain was associated with clearly poorer health-related functioning (Figures 3a-5b). Moreover, pain affected physical functioning (subscales PF, RP, BP and GH) more deeply than mental functioning (subscales GM, RE, SF and VI). The strongest effect was reported on the physical functioning (PF) subscale, and the weakest on role limitations because of emotional problems (RE).

PF=Physical functioning, RP=Role Limitations due to Physical Problems, BP=Bodily Pain, GH=General health perceptions, GM=General Mental health, RE=Role Limitations due to Emotional Problems, SF=Social Functioning, VI=Vitality.

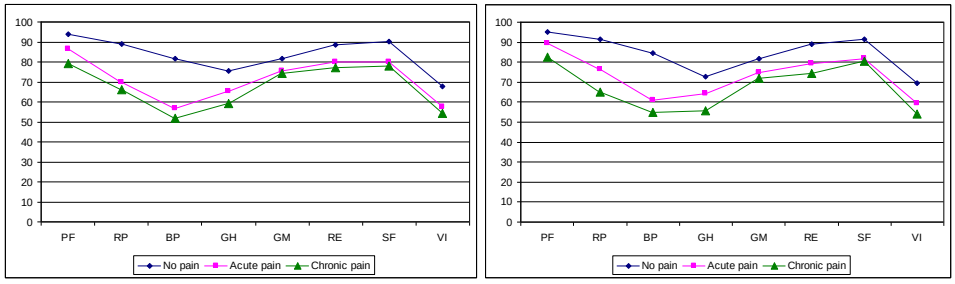
100 = best possible functioning.



Figures 3a and 3b. *SF-36 subscale means by bodily location of pain, adjusted for age, education and marital status: women on the left-hand side and men on the right-hand side*



Figures 4a and 4b. *SF-36 subscale means by the number of painful locations, adjusted for age, education and marital status: women on the left-hand side, men on the right-hand side*



Figures 5a and 5b. *SF-36 subscale means by duration of pain, adjusted for age, education and marital status: women on the left-hand side, men on the right-hand side*

Further analyses of the statistical significance and magnitude of the differences between the sub-categories of the different pain measures were carried out by means of t-tests and effect size calculations (see sub-study III, web appendix). These analyses showed that when compared to each other the associations between the different bodily locations of pain and health-related functioning were mostly statistically non-significant and the magnitude of the difference was only small or trivial. The findings were similar when acute and chronic pain were compared. However, with regard to the number of painful locations, all of the differences found were statistically significant and varied in magnitude from small to large. Thus, the bodily location of the pain and whether it was acute or chronic had a weaker effect on the variation in health-related functioning than the number of painful locations. The results were similar among both genders.

6.3.2 Sickness absence

Sub-study IV focused on the association of acute and chronic pain with sickness absence. Longitudinal personnel register data on sickness absence was combined with the questionnaire data.

Descriptive analyses showed that self-certified sickness absence spells of between one and three days was the most common (see sub-study IV Table 1). Among those reporting no pain the average number of self-certified absence days per person-year was 1.4 among the women and 0.9 among the men, and the corresponding figures for those with acute or chronic pain were 1.8 days and 1.1 days. The average number of medically certified 4-14 day sickness absence spells among the women was 0.5 per person-year among those with no pain, 0.7 among those with acute pain and 0.8 among those with chronic pain. The corresponding figures for the men were 0.3, 0.5 and 0.7. With regard to absence spells of over 14 days, the average number of spells per person-year was 0.2 for those with no pain among the women and 0.1 among the men, and the corresponding figures for acute pain were 0.3 and 0.2, and 0.4 and 0.3 for chronic pain.

The association between pain and sickness absence was further examined by means of negative binomial regression analysis (Table 10).

Self-certified absence

The association between pain and self-certified sickness absence was adjusted for age first. The rate ratio (RR) for acute pain was 1.28 (CI 1.18-1.39) among the

women and 1.19 (CI 0.95-1.49) among the men, and the corresponding figures for chronic pain were 1.36 (CI 1.28-1.46) and 1.26 (CI 1.06-1.50). Further adjustments, one-by-one, for occupational class, and physical and psychosocial working conditions had only negligible effects on the associations among the women, the biggest decrease of 14 per cent being observed for the RR of chronic pain following adjustment for physical working conditions. The adjustments resulted in somewhat stronger effects among the men than among women. As with the women, the highest RR decrease of 35 per cent was for chronic pain, again adjusted for physical working conditions.

Medically certified absence

Following adjustment for age, both acute and chronic pain were associated with 4-14-day medically certified sickness absence spells among the women and the men, the RR for acute pain being 1.53 (CI 1.38-1.70) and 1.52 (1.16-1.99), respectively. The corresponding figures for chronic pain were 1.73 (CI 1.59-1.89) and 2.11 (CI 1.72-2.60). Further adjustment for occupational class, and physical or psychosocial working conditions decreased the RRs by at most 19 per cent among the women and 38 per cent among the men. This decrease was observed for acute pain when adjusted for physical working conditions.

Following adjustment for age, both acute and chronic pain were associated with absence spells over 14 days among the women, but only chronic pain was thus associated among the men. The RRs for the women were 1.76 (CI 1.51-2.06) for acute pain and 2.63 (CI 2.32-2.98) for chronic pain, the corresponding figures for the men being 1.20 (CI 0.81-1.77) and 2.65 (CI 2.00-3.51). As with self-certified absence and medically certified 4-14 day absence, adjusting for physical working conditions had the strongest effect on the RRs of pain. The maximum decrease among the women was 14 per cent and among the men 35 per cent, both figures referring to chronic pain. Overall, chronic pain was a stronger predictor of absence spells of over two weeks than acute pain.

Thus, adjusting for occupational class, physical working conditions, or psychosocial working conditions had only negligible effects on the associations between pain and sickness absence among the women, but somewhat stronger effects among the men. Physical working conditions was the strongest explanatory factor.

Table 10. *Rate ratios (RR) with 95% confidence intervals (CI) for self-certified, 1-3 day sickness absence spells and medically certified 4-14 day and >14 day absence spells*

	Age adjusted RR (CI)	Age+ socio-economic position RR (CI)	Age+ physical working conditions RR (CI)	Age+ psychosocial working conditions RR (CI)	Fully adjusted RR (CI)
1-3 days					
Women					
Acute	1.28 (1.18-1.39)	1.25 (1.15-1.35)	1.25 (1.15-1.35)	1.25 (1.16-1.36)	1.22 (1.13-1.33)
Chronic	1.36 (1.28-1.46)	1.32 (1.24-1.41)	1.31 (1.23-1.40)	1.33 (1.24-1.42)	1.28 (1.20-1.37)
Men					
Acute	1.19 (0.95-1.49)	1.11 (0.89-1.38)	1.09 (0.87-1.36)	1.14 (0.91-1.42)	1.08 (0.86-1.35)
Chronic	1.26 (1.06-1.50)	1.18 (1.00-1.40)	1.17 (0.98-1.39)	1.22 (1.03-1.46)	1.14 (0.95-1.36)
4-14 days					
Women					
Acute	1.53 (1.38-1.70)	1.44 (1.30-1.59)	1.43 (1.29-1.58)	1.46 (1.32-1.62)	1.37 (1.24-1.52)
Chronic	1.73 (1.59-1.89)	1.61 (1.49-1.75)	1.60 (1.47-1.74)	1.65 (1.52-1.80)	1.53 (1.41-1.66)
Men					
Acute	1.52 (1.16-1.99)	1.40 (1.09-1.81)	1.32 (1.02-1.71)	1.39 (1.06-1.81)	1.30 (1.01-1.67)
Chronic	2.11 (1.72-2.60)	1.93 (1.59-2.34)	1.78 (1.46-2.16)	1.97 (1.61-2.41)	1.71 (1.41-2.08)
> 14 days					
Women					
Acute	1.76 (1.51-2.06)	1.66 (1.42-1.94)	1.63 (1.40-1.91)	1.68 (1.43-1.96)	1.59 (1.37-1.86)
Chronic	2.63 (2.32-2.98)	2.41 (2.13-2.73)	2.38 (2.10-2.69)	2.49 (2.20-2.82)	2.28 (2.02-2.58)
Men					
Acute	1.20 (0.81-1.77)	1.13 (0.77-1.66)	1.06 (0.72-1.56)	1.09 (0.74-1.61)	1.04 (0.71-1.53)
Chronic	2.65 (2.00-3.51)	2.35 (1.78-3.09)	2.11 (1.60-2.79)	2.23 (1.69-2.96)	1.94 (1.46-2.56)

Finally, calculations of aetiological fractions showed that among the women and men, respectively, pain accounted for 13 and eight per cent of self-certified absence spells, 25 and 23 per cent of medically certified 4-14 day absence spells, and 37 and 30 per cent of absence spells of over 14 days (Table 11).

Table 11. *Aetiological fractions (%) of self-certified and medically certified sickness absence spells attributable to acute and chronic pain*

	Self-certified sickness absence spells		**Medically certified sickness absence spells**			
	1-3 days		4-14 days		over 14 days	
	Women	Men	Women	Men	Women	Men
Acute pain	3.8	2.1	6.5	4.7	7.5	1.7
Chronic pain	9.2	5.7	16.5	20.0	29.9	27.8
TOTAL	13.0	7.8	23.0	24.7	37.4	29.5

7. Discussion

This thesis was based on cross-sectional questionnaire data on ageing employees of the City of Helsinki, with linkages to personnel register data. The aim was to acquire epidemiological information on pain among an employee population, including its prevalence, risk factors and consequences. This chapter summarizes the main results of the study and then discusses them in more detail in the light of its specific aims and in relation to other studies in this field. The strengths and limitations of the study are assessed, and conclusions are drawn.

The main results were:

A total of 44 per cent of the women and 36 per cent of the men reported pain.

Of the various socio-economic indicators studied, education and occupational class showed associations with pain: employees with a low level of education and in lower occupational classes were more likely to report pain than their better-off counterparts.

Of the wide range of psychosocial factors investigated, it was found that, in addition to Karasek's job strain, organizational injustice, experiencing bullying at workplace, and problems with the work-home interface were all associated with pain. However, there were differences between men and women, and between acute and chronic pain.

Those with pain problems reported decreased health-related functioning. The pain affected physical functioning more than mental functioning. The bodily location and whether pain was acute or chronic were less important in terms of variation in functioning than the number of painful locations.

Pain accounted for a significant amount of sickness absence. Both acute and chronic pain predicted sickness absence, but chronic pain was a much stronger predictor, especially of longer absence spells.

7.1 Risk groups and risk factors

This study provided estimates of the prevalence of pain among ageing municipal employees. According to the findings, 24 per cent of the male employees and 29 per cent of the female employees suffered from chronic pain, and a further 12 and 15 per cent, respectively, reported acute pain. Thus far there has been a lack of

research on pain regardless of the location among employees representing various occupations, and direct comparisons with previous results are therefore not possible. Prevalence figures from general populations are available, yet the variation in these estimates is large, from six to 55 per cent (Andersson et al. 1993; Blyth et al. 2001; Eriksen et al. 2003; Mäntyselkä et al. 2003; Rustøen et al. 2004a; Breivik et al. 2006; Gureje et al. 1998). Comparison with these figures is also limited in that target populations in general population studies represent much wider age groups than in the present study, and also include those who are out of working life. However, according to a recent population-based study conducted in Finland, in which a similar definition of chronic pain was adopted as in the present study, 35 per cent of the population suffer from chronic pain (Mäntyselkä et al. 2003). This population-level prevalence of chronic pain is broadly in line with the results of this study, taking into account the fact that the participants of the present study were still in working life and were therefore probably healthier. The effect of the differences in selected age groups is harder to estimate. Studies on acute pain regardless of the location or diagnosis are rare, even on the population level, and it is therefore not possible to make direct comparisons.

Socio-economic risk groups

Socio-economic status is a comprehensive theoretical construct that cannot be assessed on any single measure, and several indicators are needed to cover its multiple social and financial aspects (Laaksonen et al. 2005; Galobardes et al. 2007). Four indicators of socio-economic status were therefore used in investigating its associations with pain: education, occupational status, income and housing tenure. There is evidence of such an association in each of these, although the results are not fully consistent, but the mutual significance has not been studied (Eriksen et al. 2003; Andersson et al. 1993; Elliott et al. 1999; Smith et al. 2001; Blyth et al. 2001; Rashiq and Dick 2009). The results of this study showed that, among the women, education in particular, but also occupational class were associated with differences in reporting pain, whereas among the men such differences were by occupational class. Among both genders housing tenure and income were unassociated with pain following mutual adjustments. The gender differences in the results may be related to differences in the occupational distributions, but also to the small number of men in this study: even though the

figures for the men were, in principle, similar to those for the women they often failed to achieve statistical significance.

The findings concerning the association between low level of education and higher pain rates are in line with those achieved in population-based studies carried out in Denmark, the UK and Australia (Eriksen et al. 2003; Smith et al. 2001; Blyth et al. 2001). The present results therefore underline the fact that those with lower educational attainment form a risk group for pain problems. A potential explanation for this association lies in the knowledge resources education provides (Galobardes et al. 2006): they may affect the ability to recognize and avoid adverse work exposures, raise awareness of the need to seek care in good time, and enhance the capacity to cope with symptoms.

Previous studies on occupational class are scarce, probably due to the fact that research on pain regardless of the location, relies on population-based samples in which it is difficult to classify those without an occupation. However, some previous studies have shown that being a manual worker is associated with a higher prevalence of chronic pain (Andersson et al. 1993; Bergman et al. 2001). The results of this study support the role of occupational class as a factor contributing to an uneven distribution of pain. Occupational class differences are likely to depend on work factors such as physical and psychosocial demands. However, the mechanisms or pathways through which socio-economic status affects pain rates among employees need to be examined in further studies.

Contrary to some previous findings, housing tenure and income, which reflect material aspects of socio-economic circumstances (Galobardes et al. 2006), were not associated with pain in this study when all the measures of socio-economic status were considered simultaneously. This could indicate that the measures of education and/or occupational class used in this data set reflect material circumstances in addition to the traditional areas they are assumed to reflect. Similar results concerning the association between income and health have already been reported with the same data (Laaksonen et al. 2005), but the lack of association with housing tenure is characteristic of pain. A Scottish study (Smith et al. 2001) was the first to report an association between pain and housing tenure. The lack of association in the Finnish data might relate to differences in housing structure and conditions between Scotland and Finland: at the time of the study rental housing was more common in Scotland than in Finland. House ownership is common in Finland, the standard of housing, even in the rental market, is reasonably high and rental housing is available mostly through the municipalities.

Thus, it is likely that housing tenure reflects socio-economic status differently in Finland than in Scotland.

Assessment of the relevance of the different measures of socio-economic status within a broad socio-economic framework revealed that two of them were more important than the others. It could be argued that there was over-adjustment when all four measures were studied simultaneously, but previous studies in this area have shown that, although these factors represent the same features of socio-economic status to some extent, they also represent independent features, and thus simultaneous adjustment has the potential to reveal their mutual importance (Daly et al. 2002; Lahelma et al. 2004). Mechanisms mediating the association between socio-economic status and pain, which could include aspects of the work environment, warrant further study.

Work-related psychosocial risk factors

This study utilized a broader framework of work-related psychosocial factors than previous studies in this area. This approach proved useful. It was found that Karasek's job strain, a measure used exclusively in most previous studies on psychosocial risk factors, was associated with pain largely independently of the other studied psychosocial work factors. The implication is that job strain could be used as a single measure of the psychosocial work environment if the aim is to restrict the study of psychosocial exposures to those related to work tasks. Overall, the present results support findings suggesting that job strain is associated with pain (e.g., Amick et al. 1998; Soares and Jablonska 2004; Hannan et al. 2005; Leroux et al. 2006).

In addition to a high level of job strain, difficulties with the work-home interface were associated with a higher risk of both acute and chronic pain among the women, whereas bullying at workplace was only associated with acute pain, and there was no association between pain and organizational justice. Among the men bullying increased the risk of acute pain, and high job strain and organizational injustice increased the risk of chronic pain. There is a lack of research on the associations between the aforementioned psychosocial measures and pain outcomes, although they have all previously been found to be associated with a variety of measures of poor health and distress (Einarsen et al. 1996; Vartia 2001; Elovainio et al. 2002; Kivimäki et al. 2003; Kivimäki et al. 2004; Hoel and Faragher 2004; Väänänen et al. 2004; Elovainio et al. 2006; Winter et al. 2006). It therefore seems that the psychosocial work environment has an impact on ill-health,

including pain. This underlines the claim of Lisa Berkman and Ichiro Kawachi that "…all states of health and disease are to some extent influenced by psychosocial conditions. Rarely for any disease there is a single necessary and sufficient cause of disease" (Berkman and Kawachi 2000).

Social support from supervisors and co-workers has frequently been associated with pain (e.g., Ariens et al. 2001; Hoogendoorn et al. 2001) in that those with less support report pain more often. There was no evidence of an association between social support and pain in this study, however, possibly because the variable used measured the general level of social support and not only support from supervisors and co-workers.

It was not possible to confirm the direction of the causality of the association between psychosocial risk factors and pain given the cross-sectional nature of the data. It is assumed that adverse psychosocial factors predict pain, and there is some longitudinal evidence from previous studies supporting this (van den Heuvel et al. 2005; Östergren et al. 2005), but it is also possible that the causality is the reverse: those with pain may end up in a situation in which they are bullied, or consider that they are treated unjustly on account of their pain problems. Causality should be studied further in longitudinal settings.

Gender differences per se were not the focus of this study, but it became evident that differences in psychosocial risks exist between women and men. The two dimensions of the work-home interface were associated with pain only among the women. This may relate to the different roles in carrying out household tasks: women may (still) carry the main responsibility and are therefore more prone to facing conflicting demands, which affect health outcomes. Organizational injustice was associated with pain among men, on the other hand. Men may see and experience justice issues differently from women. It should be noted that the women and men in this data set differed in terms of the distribution of occupations, which may have affected the results. However, the identified gender differences in psychosocial risk factors for pain warrant further study among employees.

As stated earlier in this study, the mechanisms underlying the association between psychosocial work factors and pain are not yet clear, although there are some plausible suggestions: physiological stress reactions, changes in behaviours, and changes in coping resources (Bongers et all. 1993; Hoogendoorn et al. 2000; Bongers et al 2006), for example. All of these are likely to be related to stress

mechanisms. According to Selye's theory, prolonged stress affects the sympathetic nervous system, the immune system and hormone balance, which may cause ill-health and pain (Selye 1974; Szanton et al. 2005; Estlander 2003). For example, it has been suggested that dysfunction in the hypothalamic-pituitary-adrenal (HPA) stress response system moderates the effect of psychosocial risk factors in the development of chronic widespread pain (McBeth et al. 2007). Moreover, the psychosocial burden may cause stress and stress may trigger muscle tension, which may eventually lead to pain problems (Bongers et al. 1993). If coping resources are affected by stress, pain problems may appear worse than in less stressful situations. Work postures and methods may be negatively affected by the psychosocial burden, or may lead to biomechanical overload via less controlled movements and increased muscle coactivity (Marras et al. 2000).

7.2 THE CONSEQUENCES OF PAIN

The purpose of the two studies on the consequences of pain was to estimate the magnitude of the problems it causes employees in terms of its associations with work ability. The focus in the first, cross-sectional study was on health-related functioning and in the second, longitudinal study on sickness absence.

HEALTH-RELATED FUNCTIONING AND PAIN

Those with pain reported lower levels of both physical and mental functioning than those with pain, the stronger effect being on physical functioning. These results are in line with those reported in a study on chronic pain conducted among the general population in Denmark (Eriksen et al. 2003) in which the authors were able to compare the effects on those with pain problems to the mean values of the general populations, and with two studies on musculoskeletal disorders among the general population in France and the Netherlands (Roux et al. 2005; Picavet and Hoeymans 2004).

When the association between pain and functioning was analysed in relation to different pain outcomes it was found that a simple count of painful locations showed the most variation. This might therefore be a good measure for detecting those at risk in terms of functioning. There were only minor differences in this respect between single bodily locations (e.g., the neck and shoulder, the low back, and the lower extremities) and between acute and chronic pain. This indicates that with regard to functioning neither the location of the pain nor how long it has

lasted is as relevant as the number of locations in which it occurs. A simple count of painful locations takes into account all instances of pain, in contrast to the often used measures of widespread pain, that restrict the cases to those with pain in both the left and right side of the body, and above and below the waist (e.g., Bergman et al. 2002). Other measures commonly used in scientific studies include regional and single side pain, but both have deficiencies. Regional pain merely covers the rest of those experiencing pain that is not widespread, and thus has little relevance in terms of this study. Moreover, genuine single side pain is rare (Andersson et al. 1993; Picavet and Shouten 2003; IJzelenberg and Burdorf 2004; Carnes et al. 2007; Kamaleri et al. 2008). Thus, any studies concerning only one pain location are prone to bias if the potential existence of other painful locations is not taken into account.

In the light of the findings reported in the present study and by Ektor-Andersen et al. (1999) it is evident that the effect of pain on functioning is determined by the total burden of pain rather than pain in any single location. Kamaleri et al. (2008) reported similar results in their later study on the association between functioning and localized vs. widespread pain among the normal population. Those with localized pain, i.e. in a single site, reported good functioning, and there were only minor differences between different types of localized pain. Functioning decreased linearly with an increasing number of painful locations. Thus, general measures of pain are applicable and also necessary in research on the association between pain and functioning among large populations, as well as in occupational health care for identifying those at a high risk of deterioration in functioning.

Bergström et al. (2007) recently found in their three-year follow-up survey that lowered levels of physical activity as measured on the SF-36 predicted subsequent sickness absence due to neck or back pain. Laaksonen et al. (2010 submitted) analyzed the association between SF-36 sub-scales and subsequent sickness absence with the same data as used in the present study. The subscale of bodily pain was most strongly associated with over two weeks absence spells. This finding suggests that the SF-36 health-related functioning scale and its bodily pain subscale have predictive value in terms of sickness absence due to pain, and are therefore useful proxies for work ability. In addition, the strong association of SF-36 bodily pain subscale strengthens the results of sub-study IV on the associations between pain and sickness absence.

Sickness absence and pain

The aim in sub-study IV which focused on the longer-term consequences of pain was to examine the association between pain and sickness absence, taking work factors into account, and to assess the extent of the burden of pain.

Pain predicted sickness absence. Moreover, the examined work-related factors and occupational class had only a slight effect on the association. Psychosocial factors had negligible effects, but occupational class and especially the physical work load, explained a small proportion of the association. In other words, the risk factors predicting pain in sub-study II did not affect its association with sickness absence. Similar results have been reported in the Netherlands, where it was found that the risk factors for pain-related musculoskeletal complaints were different from those for sickness absence due to these complaints (IJzelenberg and Burdorf 2004). However, given that the number of respondents in the sickness absence group was very small in that study, the results are at best indicative. A wider-ranging follow-up study conducted in Sweden reported that physical factors predicting the occurrence of pain did not predict sickness absence due to pain (Bergsröm et al. 2007). These findings support the results of the present study. Thus, pain seems to be a rather independent predictor of sickness absence.

The burden of pain on sickness absence was considerable, and higher in longer, medically certified absence than in shorter, self-certified absence. Similar results have been found concerning the association between generic health measures and sickness absence (Marmot et al. 1995). Medically certified absence requires a doctor's examination and diagnosis and is therefore likely to be related to more serious conditions than self-certified absence.

Further, it was found that the burden was mostly related to chronic pain. Previous studies on pain and sickness absence have usually included pain in the sickness absence outcome in questions such as "Have you been sick listed due to neck or back pain during the past year?" (Bergström et al. 2007). In addition, in some of these studies certain qualities of pain, such as intensity, severity, or the number of painful locations were used as predictors of subsequent sickness absence due to pain (Lötters and Burdorf 2006; Nilsson et al. 2005). However, there is no previous study on the total burden of pain or chronic pain on sickness absence. Nevertheless, these previous studies indicate that the intensity and severity of pain are associated with sickness absence due to pain. This is in line with the

results of the present study according to which chronic pain, which is considered to be more severe, is more strongly associated with long-term absence than acute pain. These findings enhance current knowledge about the role of pain as a predictor of sickness absence of various lengths.

7.3 Towards a comprehensive epidemiological view of pain among employees

This thesis concerns two main areas of epidemiology, social i.e. macro epidemiology and risk-factor epidemiology (see Poole and Rothman 1998). Studies on the consequences of pain could be seen as belonging to applied epidemiology. This current approach provides a broad view on the epidemiology of pain among employees and fills some obvious gaps in the research.

Generic measures of pain were used in the study in accordance with the objective to describe the overall pain experience, and related risk factors and consequences among an employee population. It was found that the consequences of pain in terms of health-related functioning were more closely related to the number of painful locations rather than to single bodily locations, or duration of pain. Thus, the use of generic measures proved advantageous and could be recommended for studies in which the aim is to enhance understanding of the overall significance of pain for health and well-being. Generic measures were also used in the risk factor analyses. Risk factors related to the psychosocial work environment were identified, presumably common to pain irrespective of the location. This is useful in terms of public health. However, there is a possibility that these results were dominated by the risk factors of the most prevalent pain problem(s), in other words neck and shoulder pain and back pain. Yet, some previous studies have reported similarities across bodily locations especially in psychosocial risk factor profiles. It might be just as effective to use single pain locations in risk factor studies provided that the participants are restricted to people who genuinely have pain in only one bodily location, but from the public health perspective generic measures seem equally applicable.

About seven per cent of the employees covered in this study suffered from highly disabling, moderately or severely limiting pain. This group is likely to have serious pain problems and lowered work ability. The largest pain group, i.e. about 29 per cent of the respondents suffered from chronic pain, and an additional 15 per cent reported acute pain. What should be done about these problems among

employees, and should some of these groups be prioritized in terms of health care and prevention? If the emphasis is on providing care and alleviating suffering, those with the most serious problems should be prioritized. However, if the objective is effective prevention then priority should be given to those with acute pain given that if acute pain not is treated appropriately and promptly, it may became chronic. The results of this study shed some light on the risk factors of acute pain, which are likely to differ from those of chronic pain, but further research is required. Following the epidemiologist Geoffrey Rose, all employees should be the target of preventive actions, because a small shift in a larger population is likely to produce greater benefits in terms of public health than a larger shift, in a smaller, albeit more sickness prone population (Rose 1992). This type of population-based strategy follows the lines common in social epidemiology (Berkman and Kawachi 2000). The present study provided information on the risk factors associated with chronic pain, most of which are modifiable, and therefore potentially open to preventive actions.

7.4 Methodological considerations

Data sources

The research data for this study comprised the baseline questionnaire survey of the Helsinki Health Study and the City of Helsinki personnel registers. The baseline data were collected over three years in 2000-2002, among employees of 40 years and over. The survey response rate was 67 per cent, which is in line with many recent questionnaire surveys (Blyth et al. 2001; Eriksen et al. 2003; Mäntyselkä et al. 2003). The cross-sectional questionnaire data was used in sub-studies I-III. The questionnaire data and the personnel register data were combined to constitute follow-up data for the purposes of the sub-study IV. However, this data linkage was done only if the person concerned had given written permission (informed consent): 78 per cent of the respondents did so.

The direction of causality cannot be confirmed in the cross-sectional questionnaire data, and it is acknowledged that the association may be both ways. For example, it was assumed in sub-study II that work-related psychosocial factors affected pain reports rather than the other way around, an assumption that was based on the findings reported in several longitudinal studies (Leino and Hänninen 1995; Bildt Thorbjönsson et al. 2000; Bergman et al. 2002; van den Heuvel et al. 2005; Östergren et al. 2005). Similarly, it was assumed in the sub-study III that

pain affected health-related functioning rather than the other way round (Becker et al 1997; Monzón et al. 1998; Kerr et al. 2004; Bondegaard Thomsen et al. 2002; Bergman et al. 2004; Coste et al. 2004; Daffner et al. 2003). Again, the association could be both ways, as Bergman et al. (2004) and Coste et al. (2004) suggest.

A further issue to be considered is the healthy worker effect, in other words the possibility that those with more severe health problems may be selected out of the workforce prior to the study (Li and Sung 1999). This kind of analysis was not possible given the data sources available for this study, but it is likely that such selection exists. Thus, the results of the study are likely to underestimate poor health among the total working-age population. Further studies in longitudinal settings are needed in order to assess the magnitude of the healthy worker effect.

Due to non-response the cross-sectional data was prone to selection bias. Thus, it would be useful to know whether those responding to the questionnaire differed in any essential way from those who did not respond. This problem has been addressed in three different non-response analyses carried out by the Helsinki Health Study research group (Lallukka et al. 2002; Martikainen et al. 2007; Laaksonen et al. 2008). It seems that women, older employees, those in a higher socio-economic position, and those with higher income were more likely to respond to the questionnaire. Given that those in a higher socio-economic position are likely to be healthier than those in a lower position, it is likely that the results of this study underestimate rather than overestimate ill-health among the employees in question. Moreover, those with medically certified sickness absence were somewhat less likely to respond (Lallukka et al. 2002; Laaksonen et al. 2008).

Separate analyses were conducted for women and men because of the uneven gender distribution in the personnel of the City of Helsinki and in the data. Analysed together, the results for the women would have been predominant. In addition, there were substantial differences in occupational distribution in that the men were more likely to be in higher positions and to be engaged in more technical tasks than the women. Moreover, there is evidence that women are more likely to report pain than men, that their pain intensity is higher and that they seek and receive care more often than men (Rustøen et al. 2004a). Adjusting for gender would violate this.

Informed consent from the respondent was required before linking sickness absence register data to questionnaire data. Not all respondents were willing to give their consent – 27 per cent of the women and 21 per cent of the men refused

to do so. This is a further source of selection bias. Apart from this reverse gender difference, there were similar but smaller differences in consent-giving as in participation in the questionnaire survey (Laaksonen et al. 2008). It was considered important to find out whether differences in consent giving were systematically associated with health status. This was therefore further analysed using medically certified sickness absence as a health outcome (Laaksonen et al. 2008), but health status was found to have only a minimal effect on the association between the above mentioned factors and participation. Thus, it could be concluded that even though there were differences in participation according to some characteristics of the respondents, it is unlikely that this severely biased the results concerning the associations between the other variables and health status.

THE MEASUREMENT OF PAIN

Some of the measures used in this study may have been prone to information bias, and more specifically to recall bias. The question on which conclusions about the acuteness or chronicity of pain were based required the respondent to indicate whether the pain had lasted three months or less, or longer than three months. It is possible that in cases in which the pain had lasted for about three months the respondent could not remember exactly when it started, and the distinction between acute and chronic pain in such cases is not clear-cut. However, this is unlikely to have caused major systematic error. Another potential problem here is that one cannot be sure how the respondents understood the question about duration, in other words whether they reported only pain or pains that had lasted for three months and had occurred daily, or whether they considered regularly recurring pain (e.g., episodes of migraine that started in early adulthood) worth reporting. This should be kept in mind when interpreting the results. The validity and reliability of the single question concerning whether the respondent is currently experiencing pain, have not been studied, but as pain is a subjective experience, self-reporting is the starting point for any epidemiological study.

The validity and reliability of Von Korff's Chronic Pain Grade scale (von Korff 1992) has been tested in cross-sectional as well as in longitudinal settings (Smith et al. 1997; Elliott et al. 2000). The consistency and reliability of the measure, as well as the construct validity have proved to be good. Analyses in longitudinal settings have shown high levels of consistency between changes in CPG scores and

changes in the SF-36 pain scale (Elliott et al. 2000). The CPG has two subscales covering intensity and disability. The Helsinki Health Study questionnaire did not include the intensity subscale, and the CPG results are thus based on the disability subscale. However, when pain was categorized according to the scale construction system, intensity played no role in the higher categories, i.e. in moderately or severely disabling pain (where the main interest in this study lies). The use of these scales separately is not very common, but acceptable according Professor Von Korff, who originally developed them (personal communication).

THE MEASUREMENT OF RISK FACTORS AND CONSEQUENCES

Other significant measures in this study included indicators of socio-economic status and work-related psychosocial and physical factors, which are commonly used in health studies. Information on occupational class was obtained from the personnel registers, provided that permission had been given. Education, income and housing tenure were self-reported. It is unlikely that educational attainment and housing tenure were affected by recall bias, at least not to any meaningful extent. Income was more prone to bias in that the respondents were asked to calculate the household income. Karasek's questionnaire on job strain has been found to be reliable and valid in psychometric tests worldwide (e.g., Pelfrene et al. 2001). As some of the measures, i.e. organizational justice and the work-home interface were new in pain studies, additional tests were carried out for construct validity, which turned out to be good. However, one item "Your work involves a lot of travelling" which was not part of the original scale had to be removed from the work-to-family subscale of the work-home interface measure based on the results of the tests, and the organizational justice sub-scales were combined in a single measure. Bullying at the workplace was assessed on one question which included a definition of bullying. A similar measure has been used previously in several studies and has proved to be effective in detecting bullying at workplace (Vartia 1996; Lehto and Sutela 2004; Vartia 2001; Kivimäki et al. 2000; Hansen et al. 2006). The SF-36, which is a widely used measure that has gone through a thorough validation process (Ware 2000), was used to measure health-related functioning. The measures of sickness absence were based on the employer's register data on which wages are based and are therefore likely to be reliable.

Another problem that is typical of questionnaire surveys is negative affectivity, it other words respondents' general negative approach to life may colour the responses. Thus, those with negative affectivity may be more likely to express

health concerns and more readily report other negative aspects of their life, such as pain. Watson and Pennebaker (1989) suggest that negative affectivity should be controlled for in stress-related studies, but conflicting views have also been expressed (Spector et al. 2000). We were not able to adjust for it, thus it is possible that it caused some overestimation in the results, especially in sub-study II, in which work-related psychosocial factors were studied in relation to pain.

The confounding effect of the physical work environment and health behaviours was controlled for when it was considered necessary. It is possible that there were other important confounders that were not controlled for, however. For example, depression is associated with pain and is likely to be associated with the outcomes of functional capacity, but the data lacked a reliable measure of current depression.

Strengths

The most significant strengths of this study were the large sample size and the possibility to link longitudinal register data that was considered reliable to the questionnaire data. Extensive information on pain among employees was obtained in terms of several pain outcomes. The study also incorporated a wide variety of both blue-collar and white collar occupations, which facilitated assessment of the meaning of different work-related exposures. The work environment was measured in accordance with several psychosocial and physical factors, some of which are new to pain research. Measures of health behaviours were also available. Being able to consider for these factors was valuable in order to single out the effects of the variables that were of focal interest.

7.5 Policy implications

People with pain problems, and especially chronic pain, constitute a challenge in occupational health care. This study produced findings that may prove useful in preventing or alleviating such problems. For example, it would be helpful to target prevention and care to groups that are more at risk to have pain problems, such as people with a low level of education of in a low occupational class. Socio-economic differences in health are common and pain is no exception. Efforts to narrow such differences should be continued.

Several work-related psychosocial risk factors were identified, some of which are novel. Information about such factors may be useful in attempts to prevent pain

problems, and even when pain is present, bringing about change in them may have positive consequences. Attention should be paid to both the physical and psychosocial work environment, and to the risk factors that are modifiable in both domains. This requires collaboration between personnel management and occupational health care. For example, workplace bullying is not uncommon, and should be dealt with as soon as detected. In many cases it is possible to alleviate job strain that is related to the working pace, work arrangements, the amount of work relative to the time available, and the possibility to influence one's work, for example. Perceptions of organizational injustice may also be discussed. Problems concerning the work-home interface in other words combining work and home duties could be eased through the introduction of flexibility to work.

Overall, a more comprehensive view on pain may be beneficial as a complementary approach to the traditional perspective which concentrates to separate diagnoses of painful disorders at various body sites or single bodily locations. It seems that a count of painful locations could help to detect those at the highest risk of deterioration in work ability. Indeed, it could be a convenient screening tool for the early detection of high risk individuals.

8. CONCLUSIONS

Pain is a common health-related problem among employees. It affects well-being and work ability. It constitutes a considerable public health problem with wide financial implications for the sufferer, the employer, and society. This study provided epidemiological information about groups at risk, the risk factors and the consequences of pain that could be of use to occupational health care professionals, employers and health policy decision makers in tackling pain problems and developing preventive measures.

Inequality in health was evident in the socio-economic distribution of pain among the employees in question, but the factors associated with and the mechanisms leading to such socio-economic differences warrant further study. Socio-economic status is a proxy for some underlying causes of pain.

Further research on the risk factors for pain should focus more widely on the psychosocial environment and should use similar measures, as in this study in different settings in order to confirm the current results. The psychosocial work environment includes risk factors that are modifiable, unlike age and gender, for example.

The use of the number of painful locations as an outcome measure proved fruitful and should be pursued further for different consequences. In particular, it could be applied in occupational health care to detect those at high risk of deterioration in their work ability.

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