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Pain and sickness absence among young and early midlife Finnish municipal employees

Pi Fagerlund

ACADEMIC DISSERTATION

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"... my body is not only one perceived among others,
it is the measurant (mesurant) of all,
Nullpunkt of all the dimensions of the world."
Maurice Merleau-Ponty
The Visible and the Invisible; 1968:248–249

ABSTRACT

Pain conditions are prevalent in the working-age population and form a socioeconomically unequally distributed public health burden. The impact of pain extends beyond the suffering of both individuals and their families, affecting workplaces, occupational health services, and society at large through increased absenteeism, decreased productivity, and by placing a financial burden on healthcare and social systems. Musculoskeletal disorders and mental health conditions, both linked to chronic pain, are the most common causes of long-term sickness absence. Previous Finnish research has suggested that over 30 per cent of all long-term sickness absence spells that exceed two weeks among employees aged over 40 are due to pain-related conditions. Long-term sickness absence is of particular concern among young and early midlife employees, as it may indicate an elevated risk of early disability retirement or an ultimately premature, permanent exit from the workforce. The prevalence of pain conditions among young and early midlife Finnish employees, and the association between these conditions and sickness absence is poorly understood.

This dissertation study focused on young and early midlife Finnish employees and aimed to 1) examine the prevalence of pain in general, chronic pain, and disability due to chronic pain across different indicators of socioeconomic position throughout the life course, 2) explore the interplay between pain and mental health in relation to the risk of sickness absence, and 3) identify patterns in the long-term sickness absence of employees suffering pain, and pain- and occupation-related factors and lifestyle factors associated with these patterns.

The survey data on employees' characteristics originated from the Helsinki Health Study. The study included 4683 employees of the City of Helsinki aged 19–39 at the beginning of the study in 2017. The survey data comprised self-reported information on perceived pain, its duration and location, disability due to chronic pain, sociodemographic and socioeconomic factors, physical and mental work demands, lifestyle factors, and mental health status. Longitudinal data on the sickness absence of employees who had consented to the linkage of their register and questionnaire data were collected from the City of Helsinki and The Social Insurance Institution of Finland one year after the questionnaire was returned (Substudy II) and from The Social Insurance Institution of Finland during the period 1 January 2018 to 31 March 2020 (Substudy III). The main statistical methods used were multinomial logistic regression analysis and group-based trajectory modelling.

Of all the 4683 participants, 42.4 per cent reported current pain, and 19.7 per cent reported chronic (≥3 months) pain. Of the 3911 employees in Substudy II, 28.1 per cent reported multisite (≥2 body sites) pain. The dissertation study showed a socioeconomic gradient in the prevalence of

chronic pain and disability due to chronic pain. A disadvantaged childhood socioeconomic position and poorer current socioeconomic circumstances, such as lower education level, manual work and perceived financial strain, were associated with chronic pain and a higher degree of chronic pain-related disability. Experiencing chronic pain or multisite pain was associated with subsequent sickness absence for one day or longer. Chronic and multisite pain were associated with long-term sickness absence (>10 working days), but when stratified by mental health, this association remained significant only in the group with concurrent poorer mental health when employees who did not report pain and had better mental health were the reference group. Women with multisite pain were at a higher risk of future sickness absence than men. The study identified three distinct patterns of long-term sickness absence during the 27-month follow-up among the employees who reported pain: none (74%), decreasing (18%) and increasing (8%). Chronic and multisite pain, obesity, smoking, manual work, and high physical workload were linked to a decreasing sickness absence trajectory, in which sickness absence was initially high but improved over time.

This study indicates that chronic and multisite pain are common elements in the professional lives of young and early midlife employees, and helping the younger workforce cope with chronic and multisite pain is essential to avert extended sickness absence spells. Strategies should focus on both broadly preventing pain among young and early midlife workers and minimizing the unnecessary socioeconomic disparities in the prevalence of chronic pain. Multidisciplinary measures targeting lifestyle and work-related factors and supporting mental health should be at the heart of initiatives aiming to promote the work ability of young and early midlife employees who experience chronic or multisite pain and who are expected to remain occupationally active for many more decades.

SAMMANFATTNING

Smärttillstånd är vanliga i den arbetande befolkningen och utgör en folkhälsobörda som är ojämlikt socioekonomiskt fördelad. Konsekvenserna av smärttillstånd berör drabbade individer och närstående, men ses också på arbetsplatser, i företagshälsovården och i andra samhällssektorer i form av sjukfrånvaro, produktivitetsförlust, och kostnader relaterade till sjukvård och sociala förmåner. Muskuloskeletala och psykiska sjukdomar utgör de vanligaste orsakerna för långtidssjukfrånvaro och båda sjukdomsgrupperna är kopplade till kronisk smärta. Över 30% av de sjukfrånvaroperioder som överstiger två veckor hos finska kommunala arbetstagare över 40 år har visat sig vara relaterade till smärta. Långtidssjukfrånvaro indikerar en förhöjd risk för tidig sjukpensionering och förtida utträde från arbetsmarknaden och är således ett observandum bland yngre arbetstagare med en lång förväntad tid kvar i arbetslivet. Den befintliga kunskapen om förekomsten av smärttillstånd bland yngre finländska kommunalt anställda och kopplingen till sjukfrånvaro är trots allt knapp.

Den här avhandlingen fokuserade på yngre finländska arbetstagare och syftade till att 1) kartlägga förekomsten av smärta på ett generellt plan, samt specifikt kronisk smärta och funktionspåverkan relaterad till kronisk smärta i relation till socioekonomiska faktorer i barndomen och i vuxen ålder, 2) undersöka samspelet mellan kronisk och multifokal smärta och psykisk hälsa i relation till risken för sjukfrånvaro och 3) identifiera mönster i långtidssjukfrånvaro bland arbetstagare med smärta, samt smärt-, livsstils- och arbetsrelaterade faktorer kopplade till dessa mönster.

Enkätdata inhämtades från Helsinki Health Study-kohortstudien. Studien omfattade 4683 av Helsingfors stads arbetstagare som vid studiens början år 2017 var 19–39 år gamla. Enkätmaterialet omfattade information om förekomsten av smärta, dess duration och lokalisation, funktionspåverkan relaterad till kronisk smärta, demografiska och socioekonomiska faktorer, fysisk och mental arbetsbelastning, livsstilsfaktorer och psykisk hälsa. För arbetstagare som hade givit sitt godkännande till sammankoppling av enkät- och registerdata inhämtades longitudinella registerdata över sjukfrånvaro från Helsingfors stad och Folkpensionsanstalten för ett år efter att enkäten returnerades (delstudie II) och från Folkpensionsanstalten under perioden 1.1.2018-31.3.2020 (delstudie III). Som huvudsakliga statistiska metoder användes multinominell regressionsanalys och trajektoranalys.

Av 4683 inkluderade arbetstagare rapporterade 42,4% smärta och 19,7% kronisk (≥ 3 månader) smärta. Av 3911 arbetstagare inkluderade i delstudie (II) rapporterade 28,1% multifokal (≥2 kroppsdelar) smärta. Studien visade på en socioekonomisk gradient i förekomsten av kronisk smärta samt funktionspåverkan relaterad till kronisk smärta. Ofördelaktiga socioekonomiska förhållanden i barndom och vuxen ålder, såsom lägre

utbildningsnivå, manuellt arbete och upplevda ekonomiska svårigheter var associerade med kronisk smärta och en högre grad av funktionspåverkan relaterad till kronisk smärta. Kronisk och multifokal smärta var associerade med sjukfrånvaro med en varaktighet på minst en dag, men vid stratifiering for mental hälsa kvarstod associationen endast för gruppen med samtidig sämre mental hälsa, då referensgruppen var arbetstagare utan smärta och med bättre mental hälsa. Kvinnor med multifokal smärta hade högre risk för senare sjukfrånvaro jämfört med män. Studien identifierade tre distinkta långtidssjukfrånvaromönster bland arbetstagare med smärta under 27 månaders uppföljning; ingen (74%), sjunkande (18%) samt ökande (8%). Kronisk och multifokal smärta, fetma, rökning, manuellt arbete och hög fysisk arbetsbelastning var kopplade till den sjunkande utvecklingsbanan i vilken sjukfrånvaron initialt var hög men minskade under uppföljningen.

Studiens resultat belyser att smärtrelaterade tillstånd är vanliga bland yngre arbetstagare, samt vikten av att stödja yngre arbetstagare med smärta för att möjliggöra förbyggande av sjukfrånvaro. Insatser bör riktas mot att förebygga smärta bland yngre arbetstagare och minimera undvikbara socioekonomiska skillnader i förekomsten av smärta. Multidisciplinära åtgärder riktade mot ogynnsamma livsstils- och arbetsrelaterade faktorer samt stödjande av det psykiska välbefinnandet bör betonas i planering av insatser ämnade till att stödja arbetsförmågan hos yngre arbetstagare med kronisk och multifokal smärta och som förväntas ha en lång tid kvar i arbetslivet.

TIIVISTELMÄ

Kipu on merkittävä kansanterveysongelma ja yleinen oire työikäisessä väestössä. Kipu ei kosketa vain yksilöä ja hänen läheisiään, vaan sen vaikutukset näkyvät myös työpaikoilla sekä yhteiskunnassa sairauspoissaoloina, tuottavuuden laskuna ja sosiaali- ja terveydenhuollon kustannuksina. Pitkien sairauspoissaolojen tavallisimmat syyt, tuki- ja liikuntaelinsairaudet ja mielenterveyden sairaudet, ovat myös yhteydessä krooniseen kipuun. Suomalaistutkimuksessa on osoitettu, että yli 30 % kaikista yli kahden viikon pituisista sairauspoissaoloista yli 40-vuotiailla työntekijöillä aiheutuu kivusta. Pitkittyneet sairauspoissaolot nuorilla ja varhaiskeski-ikäisillä työntekijöillä ovat erityisen huolestuttavia, koska pitkät sairauspoissaolot ovat yhteydessä työkyvyttömyyseläkkeelle siirtymiseen ja ennenaikaiseen työelämästä poistumiseen. Kivun esiintyvyydestä nuorilla ja varhaiskeski-ikäisillä suomalaisilla työntekijöillä on kuitenkin vain vähän tietoa.

Tämä tutkimus keskittyi nuoriin ja varhaiskeski-ikäisiin työntekijöihin ja sen tavoitteena oli 1) tutkia kivun ja krooniseen kipuun liittyvän haitan esiintyvyyttä elämänkulun aikaisten sosioekonomisten tekijöiden valossa, 2) tutkia kivun ja mielenterveyden yhteisvaikutusta sairauspoissaoloihin ja 3) tunnistaa pitkien sairauspoissaolojen erilaisia kehityspolkuja niillä työntekijöillä, jotka raportoivat kipua, ja selvittää miten erilaiset kipuun, elintapoihin ja työhön liittyvät tekijät ovat yhteydessä kehityspoluille kuulumiseen.

Väitöskirjatutkimukseen käytettiin kyselytietoa kerättyä osana Helsinki Health Study -tutkimusta 4683 Helsingin kaupungin työntekijältä, jotka lähtötilanteessa vuonna 2017 olivat 19–39-vuotiaita. Kyselylomakkeella kerättiin tietoa kivun esiintyvyydestä, kivun kestosta, siitä missä kipu esiintyy, krooniseen kipuun liittyvästä haitasta, sosiodemografisista ja sosioekonomisista tekijöistä, fyysisestä ja psyykkisestä työkuormituksesta, elintavoista ja psyykkisestä terveydestä. Kyselyvastaukset yhdistettiin Helsingin kaupungin ja Kelan sairauspoissaolorekisteritietoihin, mikäli vastaaja oli antanut kirjallisen suostumuksen tietojen yhdistämiseen. Seuranta-aika oli vuosi kyselyn palauttamisesta osatyössä II ja 1.1.2018–31.3.2020 osatyössä III. Pääasiallisina tilastollisina menetelminä käytettiin multinomiaalista logistista regressioanalyysiä ja kehityspolkuanalyysiä.

Kaikista 4683 työntekijöistä, 42,4 % raportoi kipua ja 19,7 % raportoi kroonista (≥ 3 kuukautta) kipua. Osatyön (II):n 3911 työntekijästä 28,1 % raportoi monipaikkaista (≥2 paikkaa) kipua. Kroonisessa kivussa ja kroonisen kivun haittaavuudessa oli sosioekonomisia eroja tarkasteltaessa sekä lapsuuden että aikuisuuden sosioekonomista asemaa. Epäsuotuisat lapsuuden ja aikuisuuden sosioekonomiset olosuhteet, kuten matala koulutustaso, ruumiillinen työ ja koetut taloudelliset vaikeudet olivat vahvimmin yhteydessä

haittaavaan krooniseen kipuun. Krooninen kipu ja monipaikkainen kipu olivat yhteydessä pitkiin sairauspoissaoloihin (> 10 työpäivää), mutta kun stratifioitiin mielenterveydellä, yhteys pysyi vain niillä työntekijöillä, joilla oli samanaikainen heikompi mielenterveys verrattuna kivuttomiin työntekijöihin, joilla oli parempi mielenterveys. Naisilla, joilla oli krooninen tai monipaikkainen kipu, oli miehiä suurempi todennäköisyys sairauspoissaoloihin. Tutkimuksessa tunnistettiin kolme pitkäaikaissairauspoissaolojen kehityspolkuja: ei yhtään pitkiä sairauspoissaoloja (74 %), vähenevät sairauspoissaolot (18 %) ja lisääntyvät sairauspoissaolot (8 %). Niillä työntekijöillä, jotka raportoivat kroonista kipua tai monipaikkaista kipua, lihavuutta, tupakointia, ruumiillista työtä ja raskasta fyysistä työkuormitusta, oli suurempi todennäköisyys kuulua kehityspolkuun, jossa oli seurannan alussa enemmän pitkiä sairauspoissaoloja, jotka vähenivät seurannan aikana.

Tutkimuksen tulokset korostavat, että kipu on yleistä nuorilla ja varhaiskeski-ikäisillä työntekijöillä ja että on tärkeää tukea nuorempia työntekijöitä, jotka kokevat kipua, jotta voidaan ennaltaehkäistä pitkien sairauspoissaolojen tarvetta. Toimia pitää kohdistaa sekä kivun ennaltaehkäisyyn nuorilla ja varhaiskeski-ikäisillä työntekijöillä että minimoida ehkäistävissä olevat sosioekonomiset erot kroonisessa kivussa. Elintapoihin, työoloihin sekä mielenterveyden tukemiseen liittyvien toimien tulee olla keskiössä, kun pyritään tukemaan työkykyä nuorilla ja varhaiskeski-ikäisillä työntekijöillä, joilla on krooninen tai monipaikkainen kipu ja joilla odotetaan olevan edessään pitkä työura.

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LIST OF ORIGINAL PUBLICATIONS

This dissertation is based on the following two publications and one submitted manuscript:

I. Fagerlund, P., Salmela, J., Pietiläinen, O., Salonsalmi, A., Rahkonen, O., & Lallukka, T. (2023). Life-course socioeconomic circumstances in acute, chronic and disabling pain among young employees: a double suffering. Scandinavian Journal of Public Health, 51(2), 257–267. https://doi.org/10.1177/14034948211062314

II. Fagerlund, P., Shiri, R., Suur-Uski, J., Kaartinen, S., Rahkonen, O., & Lallukka, T. (2023). Separate and joint associations of chronic pain, multisite pain and mental health with sickness absence among younger employees: a register based longitudinal study. Archives of Public Health, 81(1), 97. https://doi.org/10.1186/s13690-023-01115-1

III. Fagerlund, P., Shiri, R., Walker-Bone, K., Rahkonen, O., & Lallukka, T. Long-term sickness absence trajectories among young and early midlife employees with pain and associated occupational and lifestyle factors (unpublished, submitted in February 2024)

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The publications are referred to in the text by their Roman numerals.

ABBREVIATIONS

AME	average marginal effect
BMI	body mass index
CI	confidence interval
CPHD	chronic pain, high disability
CPLD	chronic pain, low disability
GBTM	group-based trajectory modelling
MET	metabolic equivalent of task
OHS	occupational healthcare services
OR	odds ratio
RR	rate ratio
SA	sickness absence
SEP	socioeconomic position

1 INTRODUCTION

Pain conditions constitute a burden to public health, cause suffering and disability for the individual, and are a common reason for the use of healthcare services and sickness absence (SA) (Mäntyselkä et al., 2001; Rice et al., 2016; Saastamoinen et al., 2009).

The prevalence of pain among young and early midlife Finnish employees has been studied very little, despite research showing that pain conditions are common among both older Finnish employees and adolescents. It is known that the burden of pain is socioeconomically patterned, and a higher prevalence of pain conditions has been observed among employees in lower socioeconomic positions (SEP), such as employees with a lower education level and manual workers, who are generally exposed to greater physical work demands (Saastamoinen et al., 2005; Todd et al., 2019). SEP and the prevalence of pain are both intergenerationally patterned, and considering childhood and adulthood socioeconomic circumstances simultaneously could enhance our understanding of how socioeconomic circumstances throughout the life course influence the risk of pain and pain-related disability in adulthood (Lier et al., 2014).

Sickness absence is an indicator of the health of the working population and creates direct and indirect costs for employers, employees, and society (The Social Insurance Institution of Finland, 2023). Pain-related conditions are a common reason for SA and it has been estimated that they account for over 30 per cent of all long-term SA spells exceeding two weeks among Finnish employees aged 40 years and older (Saastamoinen et al., 2009). In this study, two fifths of the participants reported current pain, the majority of which reported it as chronic pain that had persisted for over three months.

The ageing of the population creates a need to extend careers and sustain the work ability of both current and future employees (Sorsa, 2020). Long-term SA during a person's early career is of particular concern, as it indicates an elevated risk of early disability retirement and subsequent social deprivation (Henderson et al., 2005; Salonen et al., 2020). A comprehensive body of literature confirms that pain is associated with subsequent SA in general working populations and among midlife and older employees (de Fernandes & Burdorf, 2016; Lallukka, Hiilamo, et al., 2020; Saastamoinen et al., 2009). Fewer studies have focused on pain and its consequences specifically among younger employees, who are expected to have decades ahead of them in paid employment and among whom pain-related work disability may have the most far-reaching consequences.

Findings from an earlier Finnish study have shown that multisite pain is associated with higher rates of long-term SA among employees over 30 years of age, and that the association becomes stronger the higher the number

of pain sites (Haukka et al., 2013). The number of pain sites reported in surveys has seemed to remain relatively stable throughout adulthood, whereas the prevalence of chronic pain among Finnish municipal employees has been observed to gradually increase from middle age up to the age of retirement (Kamaleri, Natvig, Ihlebaek, Benth, et al., 2009; Saastamoinen et al., 2005). In addition, obesity, which is associated with pain, seems to have increased among young Finnish public sector employees at the same time as self-rated work ability has declined (Hitt et al., 2007; Laitinen et al., 2024). The above-described trends and the fact that pain conditions are common among adolescents entering the labour market are noteworthy with regards to their future work ability (Hanvold et al., 2016).

Among young and early midlife employees, mental disorders and musculoskeletal diseases are the most common diagnosis categories that entitle sickness allowance in Finland, and SA due to mental diagnoses has increased in this age group in recent years (The Social Insurance Institution of Finland, 2023). Registered long-term SA have a diagnosis that entitles an employee to receive sickness allowance, but the circumstances that contribute to work disability may be more complex. Pain is often the disabling element of musculoskeletal disorders, and chronic pain is a common comorbidity with mood and anxiety disorders (Hooten, 2016). Pain and mental symptoms may interact to pose a risk of SA, but this potential joint effect has not been greatly studied among young and early midlife Finnish employees.

Factors related to occupation and physical and psychosocial working conditions may influence the risk of SA among employees working with pain (Mittendorfer-Rutz & Dorner, 2018). Lifestyle factors may also influence the likelihood of pain and of SA (Virtanen et al., 2018). However, not all employees experiencing pain need long-term SA, and thus identifying the work-related and lifestyle factors associated with the positive or negative development of long-term SA could help identify potential targets for measures to prevent pain-related SA or help identify employees at an elevated risk of long-term SA. As the Finnish public sector is dominated by female employees, who report pain more frequently than men and have more SA, addressing gender differences is important in this context (Saastamoinen et al., 2009).

This dissertation study aimed to fill the abovementioned research gaps by determining the prevalence of pain and finding the association between pain and SA in a cohort of Finnish municipal employees who were 19–39 years old at baseline in 2017. It consisted of three substudies. The first substudy examined the prevalence of pain, particularly chronic pain and chronic pain-related disability, and its association with indicators of childhood and current socioeconomic circumstances. The second substudy examined the separate and joint associations of chronic pain, multisite pain, and mental health in relation to both total SA and long-term SA. The third substudy identified distinct long-term SA trajectories among employees with pain at baseline, and the pain characteristics, lifestyle and occupational factors associated with these trajectories.

2 FRAMEWORK OF THE DISSERTATION STUDY

This chapter provides an overview of the dissertation's two central concepts, pain and SA, and a framework for the study. The first part covers pain, its definition and classification, and gives a brief overview of its physiology. The second part covers the definition of SA, SA certification practices, and the payment of sickness allowance in Finland.

2.1 PAIN

2.1.1 DEFINITION

Pain serves as a warning mechanism and induces adaptive behaviour in response to the threat of or an actual injury. The International Association for the Study of Pain's current definition of pain is 'An unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage' (Raja et al., 2020). This definition was formulated in 2020, when it was also expanded by six additional statements highlighting that the subjective pain experience should be respected, that non-verbal ways of expressing pain exist and should be acknowledged, and that the concept of pain during the lifetime is shaped and influenced by biological, psychological, social, and cultural factors (Raja et al., 2020).

2.1.2 CLASSIFICATION

Pain is a subjective experience and can be a symptom of an underlying condition or a primary pain condition, with no identifiable underlying pathology (Treede et al., 2019). Population studies have classified pain in multiple ways, usually on the basis of pain duration, the body locations concerned, precipitating factors, or underlying disease.

The classification of pain on the basis of its duration generally distinguishes between acute and chronic pain. Acute pain is usually defined as pain lasting for up to three months, whereas chronic pain is generally defined as pain that persists or recurs beyond the expected healing time, or for three months or longer (Treede et al., 2019). In the 11th version of the International Classification of Diseases (ICD-11), chronic pain conditions are classified as a separate category of diagnoses, and chronic primary pain conditions is distinguished from chronic secondary pain conditions, a classification which strengthens the view of pain as a disease in itself, not just a symptom. Chronic primary pain conditions include pain conditions that are not precipitated by a

specific underlying disease. Examples of such conditions are fibromyalgia, migraine, and irritable bowel syndrome (Treede et al., 2019). Chronic pain conditions that are attributable to a precipitating factor or a specific underlying disease are defined as chronic secondary pain conditions. This category includes chronic cancer-related pain, chronic neuropathic pain, chronic secondary visceral pain, chronic posttraumatic and postsurgical pain, chronic secondary headache and orofacial pain, and chronic secondary musculoskeletal pain (Treede et al., 2019). Acute pain is a warning of the threat of or an actual injury, but pain that persists in the absence of any underlying pathology may have lost its significance as a warning signal, and may become more disabling than of any value for the individual. Examples of factors identified as being associated with an increased risk of developing chronic pain include genetic and epigenetic factors; environmental factors such as stress and trauma ; and factors related to interactions between genetics and the environment, such as personality, depressivity, anxiety, and catastrophizing (Morlion et al., 2018).

Studies focusing on pain attributed to specific parts of the body are common (Barthelme et al., 2021; Kaartinen et al., 2019; Lallukka et al., 2014; Lourenço et al., 2017). The number of painful body sites is yet another way in which pain has been classified. Multisite pain is generally defined as pain in two or more body parts simultaneously, but other definitions have also been used (Butera et al., 2019; Haukka et al., 2014a, 2015).

2.1.3 PHYSIOLOGY

The current clinical and mechanistic classification of pain distinguishes between nociceptive, neuropathic and nociplastic pain (Cohen et al., 2021). Nociceptive pain arises through neural activation secondary to an actual or a threat of injury to the peripheral tissues, which in turn causes inflammatory mediators to be released and activate the peripheral nerve endings. This results in their excitation and further transduction of the pain stimulus along the afferent nerve fibres to the dorsal horn of the spinal cord (Figure 1). From here, the impulse may be further transmitted along the spinothalamic and spinoreticular tracts, via the thalamus, to a complex network of brain regions, including the prefrontal cortex, the somatosensory cortex, and regions related to the regulation of hemodynamic, metabolic, cognitive, and emotional processes. The integration of the perception of pain is a cortical process and may be influenced by inhibitory mechanisms acting on multiple levels of the pain signalling pathway (Lee & Neumeister, 2020).

The two other clinical pain types are neuropathic pain and nociplastic pain. Neuropathic pain arises from an injury to the central or peripheral parts of the nervous system, such as pain after a spinal cord injury or diabetic polyneuropathy (Finnerup et al., 2021). The term nociplastic pain comprises pain conditions in which no tissue damage or neural damage can be observed. Nociplastic pain conditions are often associated with symptoms

such as fatigue, insomnia, nausea, hypersensitivity, anxiety, and depressivity, and are believed to involve plastic changes in the central nervous system, such as altered pain modulation and central sensitization, defined as 'an increased responsiveness of nociceptive neurons in the central nervous system to their normal or subthreshold afferent input' (Cohen et al., 2021; Nijs et al., 2021). Nevertheless, this classification of pain into three mechanistically distinct types is a simplification, and they overlap clinically (Cohen et al., 2021).

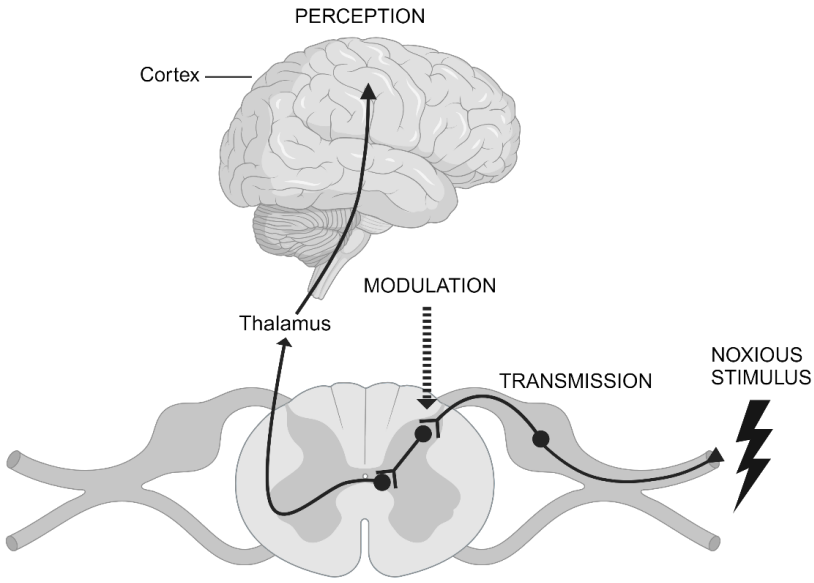


Figure 1 Simplified illustration of nociceptive pain signalling. A nociceptive stimulus induces activation of a peripheral nerve ending, from where the impulse propagates along the primary afferent neuron to the dorsal horn of the spinal cord, and further along the spinothalamic or spinoreticular tract via thalamus to the cerebral cortex, where the perception of pain arises. Pain modulation processes with inhibitory effect act on multiple levels of the central nervous system. Illustration by Pi Fagerlund.

2.1.4 BIO-PSYCHO-SOCIAL FACTORS AND PAIN

The experience of pain is personal. It may change over time and is shaped by biological, psychological, and social factors, as well as previous experiences. The bio-psychosocial model is a well-established conceptual model in pain research, and frames the multiple dimensions of pain and factors that contribute to the pain experience (Figure 2). Biological factors that influence the experience of pain include age and sex, genetic factors, pain threshold and pain tolerance, as well as factors related to an underlying disease or injury. The psychological component of the bio-psychosocial model of pain includes factors such as mood and anxiety, catastrophizing, stress and coping

mechanisms, whereas the social component involves factors related to previous pain experiences, the social environment, and economic factors (Cohen et al., 2021; Fillingim, 2017).

Multiple health related lifestyle factors are also associated with pain, such as smoking, which is associated with a higher prevalence of pain, pain intensity, and number of pain sites (John et al., 2006; Orhurhu et al., 2015). Two factors that have also been suggested to contribute to the increasing burden of pain and pain-related disability globally is the increasing prevalence of obesity (BMI ≥30) and reduced physical activity (Rice et al., 2016). Obesity is associated with multiple pain-related diseases and previous studies have suggested that the likelihood of reporting chronic pain increases with higher BMI, and that individuals with obesity to a higher degree report severe pain (D'Onghia et al., 2021; Kivimäki et al., 2022; Mills et al., 2019). Sleep disturbances are closely associated with chronic pain in a bidirectional manner (Santos et al., 2023). The association between alcohol consumption and pain is less clear (Karimi et al., 2022; Leino-Arjas et al., 2015). Evidence of the role of diet and specific foods in the risk of pain in general is scarce (Mills et al., 2019).



Figure 2 Biological, psychological, and social factors that influence the pain experience. Adapted from Cohen et al. (2021). Illustration by Pi Fagerlund.

2.2 SICKNESS ABSENCE

Absence from work can be due to several reasons, and SA is work absenteeism due to health issues. SA is an indicator of an employees' health and is associated with non-health-related outcomes such as productivity loss and costs related to healthcare and social benefits (Mutubuki et al., 2020; The Social Insurance Institution of Finland, 2023). The need for and duration of SA is affected by multiple factors, such as the actual disease, the employee's previous health status, the physical and psychosocial demands of work, and whether work adjustments can be made. The duration of SA spells are generally limited, but long and recurring SA spells indicate an elevated risk of disability retirement and permanent exit from working life (Kivimäki et al., 2004). SA spells that exceed the self-certification period require SA certification by a healthcare professional. The general SA certification criteria are that the disease in question prevents the employee from performing their usual or corresponding work, that the disease may worsen if the employee continues with their usual work (and no alternative tasks are available), or that treatment for the disease requires absence from work (Martimo & Antti-Poika, 2018a).

2.2.1 FINNISH SICKNESS INSURANCE AND OCCUPATIONAL HEALTHCARE

Finland, like the other Nordic countries, has a mandatory universal sickness insurance system (The Social Insurance Institution of Finland, 2023; Thorsen et al., 2015). Under the Employment Contracts Act, Finnish employees are entitled to a full salary from the first day of work disability and the following nine working days, counted as all weekdays and Saturdays, except for public holidays (Employment Contracts Act, 2001). Practice regarding SA certification during the first ten working days of an SA spell varies between employers and many employers allow self-certification to some extent.

Sickness allowance is an income-based benefit that is payable to insured people aged 16–67 who are unable to perform their usual or equivalent work due to illness. Sickness allowance can be paid by The Social Insurance Institution of Finland (Kela) if work disability continues after the ten-day waiting period and a diagnosed medical condition contributes to work disability (The Social Insurance Institution of Finland, 2023). The maximum period of sickness allowance is 300 working days, or approximately one calendar year. Any sickness allowance paid over the previous two years is included in this sum. A new ten-day waiting period is not needed if the employee needs SA due to the same diagnosis within 30 days. Partial sickness allowance can be granted for a maximum of 150 days if the employee is assessed as having partial work ability and working hours are reduced to 40–60 per cent of full time hours (The Social Insurance Institution of Finland,

2024). The Finnish public expenditure on sickness allowance (including standard sickness allowance, partial sickness allowance and sickness allowance for entrepreneurs) reached € 956 million in 2022 (The Social Insurance Institution of Finland, 2023).

The Occupational Healthcare Act obliges all Finnish employers to provide basic preventive occupational health services (OHS) for their employees (Occupational Healthcare Act, 2001). The minimum OHS level is set in the law, but employers can choose to provide more comprehensive services that include curative care. A checkpoint-system at 30, 60, 90, 150 and 230 days of SA is used to promote active follow up and rehabilitation of sick-listed employees in OHS if the SA is prolonged (Blomgren et al., 2023). After 30 days of SA, the employer is obliged to inform OHS of the prolonged SA (Occupational Healthcare Act, 2001). Sickness allowance must have been applied for by the 60th day. At this point, a medical certificate (Certificate B), based on a medical evaluation of work ability, is needed for continued payment of sickness allowance and Kela informs the employee of their rehabilitation options. By the 90th day of SA the employee must submit a medical report on their remaining work capacity, issued by an occupational health physician to Kela. This report is required for continued entitlement to sickness allowance. The employee can apply for disability pension if they reach the maximum of 300 days of sickness allowance within a two-year period. Of the Finnish employees who reached the maximum of 300 days of sickness allowance in 2012, 68 per cent were granted a disability pension. Of the 18 per cent who were not granted a disability pension, 80 per cent received unemployment benefits. Only 14 per cent did not apply for disability pension and 80 per cent of these were occupationally active in the following year (Perhoniemi et al., 2021).

2.2.2 SICKNESS ABSENCE IN FINLAND BY DIAGNOSES

National register data on SA spells and underlying diagnoses entitling sickness allowance, is collected by Kela (The Social Insurance Institution of Finland, 2023). Mental disorders and musculoskeletal diseases account for most long-term SA spells (>10 working days) and disability pension among Finnish employees. In the Finnish working population, musculoskeletal disorders constitute the second largest diagnostic category that contributes to long-term SA after mental disorders and are still the most common reason for long-term SA among employees over the age of 49 (Blomgren & Perhoniemi, 2022). Mental disorders are the dominant reason for work disability among employees under the age of 35, and in 2017 it surpassed musculoskeletal disorders as the most common diagnosis category contributing to long-term SA among 35–49-year-old employees (Blomgren & Perhoniemi, 2022; The Social Insurance Institution of Finland, 2023). If classified on the basis of the diagnosis set at the beginning of the work disability period, 28 per cent of the

sickness allowance periods in Finland in 2022 were due to mental disorders and 23 per cent due to musculoskeletal disorders. (The Social Insurance Institution of Finland, 2023). However, in addition to the registered diagnosis, multiple other factors may also contribute to work disability on the individual level, such as comorbidities and various individual and work-related factors (Martimo & Antti-Poika, 2018b)

In comparison to older employees, younger Finnish employees have a greater number of short SA spells and fewer long-term SA spells than older employees (Sumanen et al., 2015). However, short SA spells may also be a cause for concern. Harkko et al. have shown that frequent short SA spells are associated with long-term SA due to mental disorders among Finnish employees under 35 (Harkko et al., 2021). In Finland, mental health-related SA is increasing, particularly among younger employees. According to Kela's data, the number of long-term SA days (spells >10 working days) due to depression doubled between 2005 and 2021 among 16–34-year-old women. The number of long-term SA days attributable to anxiety disorders increased almost five-fold in this group during the same period (Blomgren, 2020).

3 REVIEW OF THE LITERATURE

This chapter provides an introduction to pain epidemiology, as well as a review of the previous knowledge on the prevalence and risk factors of pain among employees, and the role of pain as a risk factor for SA. Studies focusing specifically on the association between pain and SA among young and early midlife employees are few, which is why most of the studies included in this dissertation have examined employees of all ages or focused on older employees. With a few exceptions, studies focusing on clinical study populations or specific localized pain conditions were excluded, as the focus of this dissertation is on pain in general. Studies with similar pain classification (chronicity, number of pain sites) as those in the current studies were given priority. The studies included in the review were identified by a Pubmed-search and a manual search among studies referred to in the identified papers. Titles and abstracts were screened to identify studies that fulfilled the criteria mentioned above.

Table 1 summarizes the prevalence rates of pain drawn from occupational studies. Table 2 summarizes the findings of studies that have examined the association between pain and SA, and studies that also have accounted for concurrent mental health. Table 3 summarizes occupational studies of SA trajectories and their association with pain.

3.1 PAIN IN EPIDEMIOLOGICAL STUDIES

Epidemiology examines the distributions and determinants of diseases in populations and the reasons for their occurrence (Frérot et al., 2018). Pain epidemiology focuses on the prevalence of pain, its risk factors, protective factors, and consequences such as work disability, quality of life, healthcare usage, and societal costs (de Fernandes & Burdorf, 2016; Mutubuki et al., 2020). An array of sociodemographic, psychological, and biological risk factors for pain, particularly chronic pain, are known (Mills et al., 2019; Nicholas, 2022).

Epidemiological studies of pain among employees have generally relied on self-reported pain characteristics such as duration, the body sites involved, intensity, or disability due to pain. Multiple reasons support the use of self-reported data to measure and study pain on a group level. Studies that focus on only diagnosed pain-related conditions are restricted to individuals with ailments that have led to seeking and accessing medical care, or symptoms that fulfil diagnostic criteria. Pain is a common symptom of musculoskeletal disorders, but using diagnostic data on musculoskeletal diagnoses as a proxy measure of pain could lead to inaccuracies, as not all musculoskeletal diagnoses necessarily involve pain. Neither can pain always be attributed to a

specific underlying disease. Addressing pain as such, and not restricting it to a specific body location or diagnosis, aligns with the view of pain as a disease in itself and that common mechanisms predispose people to and maintain longstanding pain conditions (Treede et al., 2019). This makes it possible to capture the entire burden of pain in a population, to more widely examine risk factors for pain and targets of measures for pain prevention.

3.2 PAIN AMONG EMPLOYEES

Pain is a typical symptom of musculoskeletal disorders, the prevalence of which increases with age (Safiri et al., 2021). Existing research on pain among workers has so far mainly focused on midlife or older employees, or employees of all ages, rarely stratifying by age to give estimates for specifically younger employees (de Fernandes & Burdorf, 2016; Emptage et al., 2005; Haukka et al., 2014a; Saastamoinen et al., 2005, 2009; Skovlund et al., 2023).

Although less studied, the prevalence of pain among young adults has shown to be significant. Murray et al. conducted a systematic review and meta-analysis of studies of the prevalence of chronic pain among 15–34-year-old young adults in 22 countries. The pooled prevalence rate of chronic pain was estimated to be 11.6 per cent (Murray et al., 2022). In a study of 18–25-year-old British young adults, 67 per cent reported having experienced pain and three per cent severely disabling chronic pain during the last six months (Mallen et al., 2005). The prevalence and disease burden of musculoskeletal disorders among adolescents and young adults is globally expected to increase in the coming decades (GBD 2019 MSK in Adolescents Collaborators, 2024).

Understanding the early risk factors for pain is important for tackling pain conditions among young and early midlife adults and for preventing pain-related work disability in early and later careers. Pain conditions are already common among school children: a Finnish national school survey showed that 12–17 per cent of girls in upper secondary school experienced multisite pain (≥3 pain sites) daily or almost daily (Hellenius & Kivimäki, 2023). Experiencing pain at a young age is associated with a higher risk of persisting pain later in life, as well as a lower likelihood of full-time employment in early adulthood (Brattberg, 2004; Murray et al., 2020). In addition, previous studies have indicated that the number of reported pain sites may be established early and remain relatively stable throughout adulthood, and that the association between pain and work disability in terms of SA and disability retirement is stronger, the higher the number of pain sites (de Fernandes & Burdorf, 2016; Hanvold et al., 2016; Haukka et al., 2015; Kamaleri et al., 2009).

The prevalence of pain reported in occupational studies varies significantly by the context in which the studies have been conducted and the composition of the study populations, and the measures of pain prevalence are significantly heterogenous. In some studies, age has been an inclusion

criterion: for example, two smaller studies in the US and Denmark focused on employees over 50 years of age (Emptage et al., 2005; Skovlund et al., 2023). Emptage et al. showed that one fourth of their study population of US employees aged over 50 were often troubled by pain (Emptage et al., 2005). Skovlund et al. studied Danish employees aged over 50 who did physically demanding work. Of these, approximately 60 per cent reported having experienced daily or weekly musculoskeletal pain during the last three months (Skovlund et al., 2023). Previous Finnish studies based on the Health 2000 Survey and the Helsinki Health Study have focused on employees aged over 30 and 40, respectively (Haukka et al., 2013; Saastamoinen et al., 2005; Shiri et al., 2013). Other studies have not used age as an inclusion criterion and included employed individuals of all ages (de Fernandes & Burdorf, 2016; Haukka et al., 2014a).

The prevalence of pain is generally higher among women, as shown in a Finnish occupational study that presented gender-stratified prevalence rates (Saastamoinen et al., 2005). In this study, Saastamoinen and colleagues used data from the Helsinki Health Study that covered employees aged 40–60, and estimated gender-specific point-prevalence estimates for acute and chronic pain, as well as chronic disabling pain. The prevalence for all three measures was higher among women than among men. For women, the point prevalence of pain was 44 per cent, whereas for men it was 36 per cent. Chronic pain was reported by 29 per cent of the women, and 24 per cent of the men. Disabling chronic pain was reported by seven per cent of the women whereas the corresponding figure for men was five per cent. Some studies have included only women (Haukka et al., 2014a): a study by Haukka and colleagues estimated the 12-month prevalence of multisite pain (≥3 pain sites) among Finnish female municipal kitchen workers to be 52 per cent.

Many studies have focused on pain among specific occupations with higher physical work demands, such as healthcare workers, cleaners, and industrial workers (Andersen et al., 2012; de Fernandes & Burdorf, 2016). De Fernandes et al. estimated the one-week prevalence of multisite musculoskeletal pain among Brazilian shoe manufacturers and cleaners to be 30 per cent, and that of any pain to be 53.7 per cent (de Fernandes & Burdorf, 2016). Other occupational studies have assessed the prevalence of pain in samples of employed individuals with various occupations (Haukka et al., 2013; Saastamoinen et al., 2005).

No established standard measure of pain prevalence exists, which complicates the comparison of individual studies and of cohorts. The prevalence of pain has been elicited using various time periods, ranging from point prevalence to one-week, one-month, three-month and 12-month prevalence (de Fernandes & Burdorf, 2016; Mittendorfer-Rutz & Dorner, 2018; Saastamoinen et al., 2005; Skovlund et al., 2023). For example, Haukka et al. estimated the one-month prevalence of single and multisite pain in a random nationally representative sample of 30–55-year-old Finnish employees based on data from the Finnish Health 2000 survey. Here, the

prevalence of single-site pain was 32 per cent and that of multisite pain (≥2 concurrent pain sites) 33 per cent (Haukka et al., 2013). Pain prevalence within vaguer time frames has also been examined, such as whether the respondent was 'often troubled with pain'(Emptage et al., 2005). §. Table 1 presents a summary of selected key occupational studies reporting the prevalence estimates of general or musculoskeletal pain.

Table 1. *Examples of studies conducted among employees that have reported prevalence rates of pain in general or musculoskeletal pain.*

Author, year	Study population	Sample size	Prevalence measure	Pain measures	Pain prevalence
Saastamoinen et al., 2005	Finnish 40–60-year-old municipal employees.	n=1799	Point prevalence	Any pain, acute (<3 months), chronic (≥ 3 months), chronic disabling.	♀ Acute 15% , chronic 29%, chronic disabling 7%. ♂ Acute 12% , chronic 24% , chronic disabling 5%.
de Fernandes et al. 2016	Brazilian employees (women 21%, men 79%) in cleaning and shoe manufacturing.	n= 1070	1-week prevalence	Any pain, single site pain, multisite pain (≥2 sites)	any pain 54%, single site 24%, multisite 30%.
Haukka et al. 2013	Finnish 30-55-year-old employees, random sample.	n=3420	1-month prevalence	Single site pain, multisite pain (≥2 pain sites)	single site 32%, multisite 33%
Shiri et al. 2013	Finnish 30–64-year-old employees.	n=4009	30-day prevalence	Any musculoskeletal pain in ≥1 of 11 enquired body parts.	66 %
Skovlund et al. 2023	Danish >50-year-old employees with physically demanding work.	n=3050	3-month prevalence	Daily or weekly musculoskeletal pain.	60%
Haukka et al. 2014	Finnish female kitchen workers, mean age 46 years.	n=386	12-month prevalence	Multisite pain (≥3 pain sites).	52%
Mittendorfer-Rutz et al. 2017	Austrian 15–65-year-old employed individuals from a national health survey	n=8084	12-month prevalence	Severe pain.	34%
Emptage et al. 2005	U.S. residents >50 years (average 57 years).	n=8280	No specific prevalence measure (“Are you often troubled with pain?”)	Self-reported pain troubles (any).	27%

3.3 SOCIOECONOMIC FACTORS AND PAIN

Socioeconomic health inequalities are a well-recognized public health issue (Mackenbach et al., 2008; Stringhini et al., 2017). Socioeconomic circumstances, status, or position are multidimensional concepts compounded by a diversity of social and material resources such as wealth, education, occupation, income, and prestige. As different indicators of socioeconomic status may affect health differently during different phases of life, multiple SEP indicators should be considered simultaneously to enable more detailed insights into the factors that create and maintain socioeconomic health inequalities (Braveman et al., 2005; Laaksonen et al., 2005).

Adopting a life-course perspective when studying health disparities may also help improve our understanding of the social structures that create and maintain health inequalities (Jones et al., 2019). A multidimensional view of SEP that extends from childhood to adulthood may better capture the role of different SEP indicators of health during different phases of the life course. A life-course perspective when studying socioeconomic inequalities in the burden of pain among young and early midlife employees is motivated by multiple factors. Firstly, factors associated with pain, such as socioeconomic circumstances and health-related risk behaviours, may be intergenerationally patterned (Härkönen & Sirniö, 2020; Wickrama et al., 1999). Secondly, the prevalence of chronic pain follows an intergenerational pattern: children of parents with chronic pain conditions also show a higher prevalence of chronic pain (Brown et al., 2021; Lier et al., 2014). Thirdly, the association between early childhood socioeconomic environment and health outcomes for younger employees may be different to those for older employees.

Socioeconomic status and the prevalence of chronic pain are inversely associated (Prego-Domínguez et al., 2021). Existing studies of the association between socioeconomic factors and pain among workers have mainly focused on older employees (Lacey et al., 2013; Saastamoinen et al., 2005; Salonsalmi et al., 2022) or general populations (Dorner et al., 2011; Todd et al., 2019). Saastamoinen et al. studied socioeconomic differences in acute, chronic, and disabling chronic pain among 40–60-year-old Finnish municipal employees. Multiple SEP indicators, such as education level, occupational class, income, and housing tenure were considered. Among these indicators, lower education level and manual work were most strongly associated with chronic pain, particularly disabling chronic pain, after adjustment for other socioeconomic and sociodemographic factors (Saastamoinen et al., 2005). Lacey et al. studied trajectories of socioeconomic circumstances from childhood to adulthood and how these were associated with pain interference in a British study population of 2831 individuals aged over 56. The indicators representing childhood and adulthood SEP were school-leaving age and occupation. A consistently low SEP was associated with disabling pain (Lacey et al., 2013). General population studies also suggest an

inverse relationship between SEP and pain. An Austrian study of 15,474 participants aged over 15 examined the association between pain and socioeconomic indicators such as education level, income, and occupation, and found these to be gradually and inversely associated with both the prevalence of pain and the degree of disability due to pain (Dorner et al., 2011). Another study that used data from the same survey but was restricted to 15–65-year old Austrians assessed education, occupation, and income as predictors of severe pain and pain-related SA. All three SEP measures were associated with pain and pain-related SA (Mittendorfer-Rutz & Dorner, 2018). Socioeconomic differences in pain prevalence have also been studied on the European level. As part of the European Social Survey in 2014, the 12-month incidence of localized pain was elicited from participants from 19 European countries and analysed in relation to their education level. Socioeconomic gradients were observed in the prevalence of pain, although the magnitude of the inequalities differed across the enquired pain locations. Socioeconomic inequalities in pain were more distinct among women (Todd et al., 2019).

Adverse experiences in childhood are associated with chronic pain in adulthood (Bussières et al., 2023). Salonsalmi and colleagues showed that economic difficulties in childhood were associated with pain among over 40-year-old Finnish employees (Salonsalmi et al., 2022). Varinen et al. conducted a study of a random sample of 11,924 Finns and found an association between self-reported long-lasting financial difficulties in childhood and fibromyalgia (Varinen et al., 2017a). In their British study, Jones et al. similarly showed an association between parental reports of financial difficulties at the age of seven and self-reports of chronic widespread pain at the age of 45 (Jones et al., 2009). Finally, a review article and meta-analysis by Huguet et al. concluded that high quality evidence supports the association between low childhood SEP and the onset of musculoskeletal pain (Huguet et al., 2016).

Occupation is a socioeconomic indicator that has been studied in relation to musculoskeletal pain, both as such and indirectly in terms of physical and psychosocial occupational exposures. Manual work is associated with a higher risk of chronic pain than non-manual work (Mills et al., 2019). Psychosocial factors at work associated with chronic pain include poor work control, lack of ability to modify the work, work satisfaction, and the perceived difficulty of work tasks (Mills et al., 2019). In line with the phenomenon referred to as the 'healthy worker effect', which reflects how individuals in the labour market constitute a select group with better health than the general population, unemployed individuals are more likely to suffer from chronic pain (Giladi et al., 2015; Wilcosky T. & Wing S., 1987).

3.4 PAIN AND SICKNESS ABSENCE

Pain is a common reason for SA among older public sector employees (Saastamoinen et al., 2009; Shiri et al., 2021). The measures of both pain and SA have been heterogenous in studies examining this association, and few studies have focused on young and early midlife employees. This section aims to provide an overview of studies that have examined the association between pain and SA, and to address the heterogeneity of previous studies and the scarce knowledge on young and early midlife employees.

Previous occupational studies have measured pain using multiple different indicators, such as pain intensity, site, duration, recurrence, and interference (Hallman et al., 2019; Haukka et al., 2013, 2014b, 2015; Lallukka, Hiilamo, et al., 2020; Mittendorfer-Rutz & Dorner, 2018; Rysstad et al., 2022). The association between pain and SA has been studied for pain in general, musculoskeletal pain, and localized or specific pain conditions (Hallman et al., 2019; Haukka et al., 2013).

Data on SA have been obtained by different means and measured using many different indicators. Some studies have relied on self-reported SA data obtained through questionnaires or text messages (Hallman et al., 2019; Haukka et al., 2014b; Mittendorfer-Rutz & Dorner, 2018), while other studies have used register-based SA data from national registers or the employer's personnel register (Lallukka, Hiilamo, et al., 2020; Saastamoinen et al., 2009). Studies using register-based SA data have primarily been conducted in the Nordic countries (Hallman et al., 2019; Haukka et al., 2015; Haukka et al., 2013). SA data obtained from registers generally contain information on the start and end date of the SA spell, and sometimes the primary diagnosis that entitles the employee to sickness benefits. These data have been modelled and analysed differently in previous studies. Lallukka et al., as well as Saastamoinen and colleagues, modelled the number of SA episodes, whereas de Fernandes and colleagues analysed the number of SA days (de Fernandes & Burdorf, 2016; Lallukka et al., 2020; Saastamoinen et al., 2009). Studies analysing SA data as longitudinal trajectories obtained through trajectory modelling have used different SA variables to form these trajectories (Haukka et al., 2013, 2014a, 2017; Rysstad et al., 2022). Hallman et al. analysed the self-reported number of SA days per month for one year, whereas Haukka et al. analysed the annual number of SA spells that began during a six-year follow up (Hallman et al., 2019; Haukka et al., 2017).

Previous studies have consistently shown that pain is associated with future SA (Hallman et al., 2019; Haukka et al., 2013, 2014a; Lallukka, Hiilamo, et al., 2020; Rysstad et al., 2022). Lallukka et al. examined how recurring pain during follow up was associated with short (1–3 days)-, medium -(4–14 days) and long-term (>14 days) SA, and found that all three outcomes had significant associations, with longer SA having stronger associations (Lallukka, Hiilamo, et al., 2020). Another Finnish study by Saastamoinen et

al. estimated the fraction of SA attributable to pain among midlife employees (Saastamoinen et al., 2009). The results showed that pain conditions contribute to a major part of SA spells, and that the relative contribution increases with the length of the SA spell. Pain accounted for a larger share of the longer SA spells, 30 per cent and 37 per cent of the SA spells of over 14 days for men and women, respectively. De Fernandes et al. conducted a cross-sectional interview study of the association between the number of pain sites and the self-reported loss of working days during the previous year in a population of Brazilian employees. They found that the amount of SA increased with the number of pain sites (de Fernandes & Burdorf, 2016).

Applying trajectory analysis to longitudinal data on SA data makes it possible to identify latent subgroups which, if this person-oriented method was not used, could go unrecognized (Nagin et al., 2005). Hallman et al. studied SA trajectories due to musculoskeletal pain for one year among 981 Danish workers with different occupations. They identified four distinct trajectories. The largest trajectory *no sick leave* comprised 76 per cent of the study population, whereas the second largest trajectory (19%) had an increasing number of SA days per month. The factors that predicted belonging to the increasing trajectory were manual work, less leisure-time physical activity, smoking, multisite pain, and experiencing pain interference (Hallman et al., 2019). Rysstad et al. studied SA trajectories among 549 18–67-year-old Norwegian employees who had been on sick leave due to musculoskeletal disorders for at least four weeks. They identified six SA trajectories. Low self-assessed work ability and general health, as well as multisite pain were associated with trajectories with more SA (Rysstad et al., 2022). Similar studies have been conducted using data from Finland. Haukka et al. carried out a smaller questionnaire-based study of SA trajectories and their predictors over two years in an all-female population of 386 Finnish kitchen workers (Haukka et al., 2014b). They identified three SA trajectories: *no SA*, *intermediate SA* and *high* SA. Smoking, multisite pain, overweight, and depressive symptoms were all factors associated with the trajectories with more SA. In another study, Haukka and colleagues examined the number of pain sites as predictors of SA spells exceeding nine days over seven years among 30–55-year-old Finnish employees (Haukka et al., 2013). Four SA trajectories emerged. The number of pain sites at baseline was associated with higher SA rate trajectories and the associations were stronger for larger numbers of pain sites. Musculoskeletal and mental diseases, obesity, smoking and high physical workload were also among the factors associated with the SA trajectory.

One previous Finnish study has examined SA trajectories specifically among employees who have pain at baseline. Haukka et al. analysed SA (spells ≥10 workdays) trajectories over seven years among 1096 Finnish employees, who at baseline reported pain in at least two body parts (Haukka et al., 2017). Two distinct trajectories emerged, low (74%) and high (26%). Multiple work-related and lifestyle factors, such as normal weight, no

sleep disorders, and physically light work were identified as being predictive of belonging to the lower SA rate trajectory.

A larger number of painful body sites has shown to be associated with subsequent higher rates of long-term SA (Haukka et al., 2013). Chronic and multisite pain are more common among women, and women experience more all-cause SA and pain-related SA (Leinonen et al., 2018; Saastamoinen et al., 2009). Gender differences in occupations has been suggested as one factor contributing to the female dominance in SA (Haukenes & Hammarström, 2023; Laaksonen et al., 2010). However, although pain has shown to account for a higher proportion of the SA among women, few studies have assessed whether this is directly attributable to the additive risks related to gender differences in pain characteristics and SA, or if there is a synergistic interaction between gender and pain to the risk of SA, which would suggest presence of factors that more strongly predispose women to SA than men with similar pain complaints (Saastamoinen et al., 2009).

3.5 PAIN, CONCURRENT MENTAL HEALTH, AND SICKNESS ABSENCE

The World Health Organization defines mental health as 'A state of mental well-being that enables people to cope with the stresses of life, to realize their abilities, to learn well and work well, and to contribute to their communities.' The definition also states that mental health is 'an integral component of health and well-being and is more than the absence of mental disorder' (Osborn et al., 2022).

Pain, chronic and widespread pain in particular, are associated with poorer mental health (Demyttenaere et al., 2006, 2007; Hooten, 2016). Depression is more common among individuals with chronic pain, and it has been suggested that the association between pain and depressive symptoms is bidirectional (Bair, 2003; Kroenke et al., 2011). Although the two conditions may exacerbate one another, they may also respond to similar treatment (Bair, 2003). The prevalence of depression or depressive symptoms among individuals with pain varies among studies and according to the measure of pain used. Some studies have classified depression on the basis of diagnostic criteria but it is more frequently categorized on the basis of symptom-assessing questionnaires (Demyttenaere et al., 2006; Emptage et al., 2005; Melkevik et al., 2018; Shiri et al., 2013). The mechanisms behind the association between pain and depression are complex, and it has been suggested that both common genetic and neural mechanisms are involved (Hooten, 2016). Anxiety disorders are also overrepresented among individuals with chronic pain, as are substance abuse disorders (Hooten, 2016).

Comorbid symptoms of pain and mental disorders are generally associated with poorer work ability outcomes as compared to if the conditions occur separately (Demyttenaere et al., 2006; Emptage et al., 2005; Shiri et al.,

2013). Saastamoinen et al. studied both separate and joint associations between acute or chronic pain and emotional exhaustion in SA of different lengths among Finnish 40–60-year-old employees. Emotional exhaustion was measured using a modified version of the emotional exhaustion dimension of Maslach's burnout inventory questionnaire (Saastamoinen et al., 2016). They found that acute and chronic pain, both with and without emotional exhaustion, were associated with more SA, particularly SA exceeding two weeks, after adjustment for covariates.

Melkevik et al. examined whether the number of musculoskeletal pain sites and concurrent depressive symptoms were associated with SA among Danish female healthcare workers. The results indicated that depressive symptoms and the number of musculoskeletal pain sites were associated with an increased risk of long-term SA among individuals with either type of symptom, but not among those with both symptoms (Melkevik et al., 2018). Shiri et al. in turn studied the association between musculoskeletal pain, depressive symptoms, and self-assessed work ability among 4009 30–64-year-old Finnish employees. Musculoskeletal pain was associated with poorer physical and mental work ability, and co-occurring pain and depressive symptoms were more strongly associated with poorer physical work ability than either condition alone (Shiri et al., 2013).

Based on national survey data collected in four waves between 1994 and 2000, Emptage et al. studied how pain and depressive symptoms were linked to adverse health and employment related outcomes among employees in the US with a baseline mean age of 57 years. Reporting depression, pain, or both at baseline was associated with work-limiting health problems during follow up when employees without pain and depression were the reference group. Generally stronger associations were observed for the group reporting depression plus severe pain (Emptage et al., 2005). Demyttenaere et al. studied a random sample of non-institutionalized adults from six European countries (Demyttenaere et al., 2006). They found a higher prevalence of pain among those with more severe depression and that depression and pain had an additive effect on the used measure of work ability, i.e., the 'Work loss days' index, which indicates work ability and reduced productivity during the last month. Table 2 presents examples of studies that have examined the association between pain, mental health, and SA (or similar indicators of work disability) among employees.

3.6 LIFESTYLE FACTORS AND SICKNESS ABSENCE

The association between lifestyle factors and SA has been studied for both SA in general and SA related to specific diagnostic categories. Virtanen et al. conducted a multicohort study using data from French, UK and Finnish cohorts to examine the association between lifestyle factors and SA spells exceeding nine days. They found that smoking was associated with SA due to

depressive disorders and circulatory diseases (Virtanen et al., 2018). A systematic review and meta-analysis by Troelstra et al. obtained similar results and also indicated that this association was present regardless of age, gender and occupational class (Troelstra et al., 2020). Some systematic review studies using meta-analyses have found a positive association between alcohol consumption and SA (Hashemi et al., 2022; Marzan et al., 2022). Heavy episodic drinking has been shown to be associated with SA due to depressive disorders and external causes (Virtanen et al., 2018). Physically inactive employees have both a higher incidence of long-term SA, and longer long-term SA spells and low physical activity has shown to be associated with SA due to musculoskeletal, depressive, and respiratory disorders (Virtanen et al., 2018 (Høgsbro et al., 2018).

Knowledge on the association between dietary habits and SA is scarcer. A Finnish study of employees aged over 40 found a moderate association between poor dietary habits (measured by compliance with national dietary guidelines) and SA spells exceeding four days, but only among women (Laaksonen et al., 2009). An observational study showed that only increasing vegetable intake from non-daily to daily was not associated with reduced SA costs related to SA spells shorter than ten days during a four-year follow up (Salmela et al., 2020a). Obesity, however, has been associated with both SA in general and with SA related to multiple categories of diagnoses such as musculoskeletal diseases, depressive disorders, external causes, circulatory diseases, and respiratory and digestive diseases (Amiri et al., 2019;Virtanen et al., 2018). Insomnia symptoms have also been associated with higher SA rates (Hwang et al., 2022; Rahkonen et al., 2012; Sivertsen et al., 2009).

3.7 SUMMARY OF THE LITERATURE REVIEW AND GAPS IN PREVIOUS RESEARCH

Previous research has shown that pain conditions are common in the working population. Most previous studies have focused on older employees or study populations with a heterogenous age composition, whereas the predictors and consequences of pain among young and early midlife employees in particular have been examined to a smaller extent. Chronic pain is common among young adults in the general population and pain in early life is thought to predict pain later in life (Hanvold et al., 2016; Kamaleri, Natvig, Ihlebaek, Benth, et al., 2009; Murray et al., 2022). Given this, there is a need for expanded, updated knowledge on the prevalence of pain among younger Finnish employees. Knowledge on how the burden of pain is distributed among young and early midlife employees could help direct measures to prevent pain in this population.

Socioeconomic position is strongly associated with health as well as with pain (Saastamoinen et al., 2005; Todd et al., 2019). Multiple previous studies examining the association between SEP and pain have used single

indicators such as occupation or education level as an SEP measure. Socioeconomic indicators are interrelated, and a more detailed view of SEP can be obtained if multiple indicators are considered simultaneously. Expanding SEP to cover indicators spanning from childhood to adulthood may better capture the significance of socioeconomic factors during the life course for the risk of pain. Findings from previous pain epidemiological studies that have adopted a life-course perspective suggest that childhood socioeconomic factors may predict pain later in life, but they have not specifically considered pain in early adulthood, or the perceived degree of pain-related disability (Salonsalmi et al., 2022; Varinen et al., 2017b).

Pain contributes to SA (Saastamoinen et al., 2009). However, the pain measures, SA outcomes used, and the study settings of the body of literature examining this association are heterogenous, which complicates comparison. In general, and on the group level, pain is associated with more SA. This particularly concerns pain that is chronic or involves multiple body parts. Most studies of this association have been examined older employees, or employees of all ages. It is thus uncertain whether the associations between pain and SA are similar among younger employees, who are generally healthier, and have a higher proportion of SA due to mental disorders and a smaller proportion of SA due to musculoskeletal disorders than employees in older age groups. As pain is a common comorbidity to depression and anxiety disorders, examining the role of concurrent pain and mental health in relation to SA among younger employees would fill an important knowledge gap and provide insights into the symptomatology that may predict SA among employees in this age group. Approximately four fifths of Finnish public sector employees are women, and many of them work in the healthcare and education sectors. Women report more pain than men and have higher SA rates. Gender differences in the association between pain and SA thus need to be considered.

Lifestyle factors such as smoking and obesity are associated with pain, and with SA. Work characteristics, particularly manual work and ergonomic exposures are also associated with pain, and employees in manual work tend to have more SA (Pekkala et al., 2017). That pain is common among employees suggests that many employees work despite suffering pain, and only some need sick leave. Identification of the modifiable lifestyle or occupational factors that predict SA patterns over time could help better target measures to prevent SA among employees with pain. In a large Finnish nationally representative sample, Haukka et al. identified the lifestyle and work-related protective determinants of SA trajectories among employees with multisite pain. However, their study did not include the youngest employees (Haukka et al., 2017).

The above represent incentives to estimate the prevalence of pain and how it is socioeconomically patterned and to examine what factors should be targeted by measures to prevent SA among younger employees who work with pain.

Table 2. *Examples of studies that have examined the association between pain, mental health and sickness absence (or similar indicators of work disability) among employees. BMI= body mass index. SA= sickness absence.*

Author, year	Study population	Study design	Pain measures	Mental health measures	Sickness absence / work disability measure	Covariates	Statistical methods	Key findings
Saastamoinen et al. 2009	Finnish municipal employees 40-60 years at baseline (n=6616).	Longitudinal. Baseline survey data collected between 2000 and 2002 and register based SA data covering max. 3 years.	Cross-sectional survey data. No pain, acute pain (<3 months), chronic pain (≥3 months).		Number of self-certified (1-3 days) and medically certified (4-14 days and >14 days) SA spells per person year.	Age, occupational class, physical and psychosocial working conditions.	Negative binomial regression analysis.	Acute and chronic pain were associated with self-certified SA. Chronic pain was more strongly associated with medically certified SA. The effect of pain to SA increased with the SA duration.
de Fernandes & Burdorf 2016	Brazilian workers (n= 1070).	Cross-sectional. Structured interviews in 2010 and 2012.	Number of pain sites (0 to ≥4) during the previous year.		Self-reported workdays lost to musculoskeletal pain during the last year.	Age, gender, leisure time physical activity, BMI, physical and psychosocial work demands.	Cox regression analysis	The higher the number of pain sites, the higher the likelihood of SA.
Lallukka et al. 2020	Finnish municipal employees (n=3191)	Longitudinal. Repeated surveys in 2000/2 and 2007, and in 2007 and 2012, respectively. Register-based SA data.	Single- or multisite (≥2 pain sites) pain reported once or repeatedly.		Number of self-certified (1-3 days) and medically certified (4-14 days and >14 days) SA spells.	Age, gender, marital status, occupation, longstanding or pain related illness, mental disorders, obesity, working conditions.	Cox regression analysis.	Any recurrent pain was associated with self- and medically certified SA. Stronger associations for longer SA. Adjusting for social-, health- and work-related factors attenuated the associations.

Saastamoinen et al. 2016	Finnish municipal employees 40-60 years at baseline (n=6457)	Longitudinal. Baseline survey data collected in 2000 to 2002, register based SA data covering 3 years.	No pain, acute pain (<3 months), chronic pain (≥3 months)	The emotional exhaustion dimension of Maslach's burnout inventory (modified).	Self-certified SA days (spells 1-3 days), medically certified SA days (spells 4-14 days or >14 days).	Age, marital status, occupation, BMI, smoking, alcohol consumption, physical activity, somatic and mental diseases.	Negative binomial regression analysis. Analysis of synergistic interaction.	Acute and chronic pain were among women associated with SA, particularly SA >14 days, irrespective of the degree of emotional exhaustion. Synergistic interaction of concurrent pain and emotional exhaustion to the risk of SA ≥4 days. Similar results among men.
Melkevik et al. 2018	Danish female health care workers (n=6572)	Longitudinal. Cross-sectional questionnaire data and register data on social transfer payments for 550 days.	Level of musculoskeletal pain in the lower back, neck/shoulders and knees for the last 3 months. Count variable of the number of pain locations (range 0-3).	Major Depression Inventory (depressive symptoms low, medium or high).	Long-term SA (SA >4 weeks) during the 550 days after responding to the questionnaire.	Age, occupational seniority, cohabitation.	Cox regression analysis.	Depressive symptoms and the number of musculoskeletal pain locations were associated with LTSA among individuals with either symptom, but not among those with comorbid symptoms (pain + depressivity ≥medium).
Shiri et al. 2013	Finnish 30-64-year-old employees (n=4009)	Cross-sectional.	Musculoskeletal pain during the last 30 days in ≥1 of 11 enquired body parts.	Depressive symptoms (Beck's Depression Inventory ≥ 10 points)	Perceived current physical and mental work ability ("very good" to "very poor").	Age, gender, years of education, BMI, physical activity, smoking, medical conditions, physical and psychosocial workload.	Multinomial logistic regression. Analysis of synergistic interaction.	Musculoskeletal pain was associated with moderate to poor physical and mental work ability. Synergistic interaction between musculoskeletal pain and depressive symptoms was observed their association with physical work ability.

Table 3. *Examples of previous studies examining associations between pain and sickness absence trajectories.*

Author, year	Study population	Study design	Pain measures	Sickness absence measures	Covariates/Predictors of trajectories	Statistical methods	Key findings
Haukka et al. 2013	Finnish initially 30-55-year-old employees (n=3420).	Longitudinal. Nurse-led interview at baseline and register based SA data from 2002 to 2008.	Pain during the preceding month enquired for 18 body locations and combined into 4 sites.	The annual compensated number of sickness absence periods of ≥10 workdays.	Age, BMI, smoking, leisure-time physical activity, sleep disorders, physical and psychosocial workload, chronic diseases.	Trajectory analysis, multinomial regression analysis.	Four SA trajectories (low 59%, ascending 21%, mixed, 11%, high 9%) were identified. The number of pain sites was associated with the SA trajectories high, ascending and mixed, as compared to the low trajectory, after adjustment for covariates.
Haukka et al. 2014	Finnish female municipal kitchen workers, mean age 46 years (n=386).	Longitudinal. Questionnaire data collected every 3rd month for 2 years.	Pain during the last 3 months enquired for 7 body sites, multisite pain defined as ≥3 pain sites.	Self-report of sickness absence periods (yes/no) due to pain during the last 3 months.	Age, multisite pain, musculoskeletal diseases, depressive symptoms, BMI, smoking, study arm and organizational reforms.	Trajectory analysis, multinomial regression analysis.	Three SA trajectories were identified (no SA 41%, intermediate 48%, high 11%). Multisite pain, smoking and overweight/obesity were associated with the intermediate SA trajectory. Multisite pain, depressive symptoms and musculoskeletal diseases were associated with the high SA trajectory.
Haukka et al. 2017	Finnish initially 30–55-year-old employees who reported multisite pain (≥2 pain sites) (n=1096).	Longitudinal. Nurse-led interview at baseline and register based SA data from 2002 to 2008.	Pain during the preceding month enquired for 18 body locations and combined into 4 sites. Multisite pain defined as pain in ≥2 body sites.	The annual compensated number of sickness absence periods of ≥10 workdays.	Age, sex, marital status, occupation, work characteristics, physical activity, alcohol consumption, smoking, sleep disorders, BMI.	Trajectory analysis, logistic regression analysis.	Two SA trajectories emerged (low 74%, high 26%). Younger age, being man, and higher occupational status were associated with the low SA-trajectory. After adjusting for these, favourable physical working conditions, possibility to adjust workday length, encouraging work atmosphere, normal weight and not having sleep disorders remained associated with the low SA-trajectory.

Hallman et al. 2019	Danish blue- and white-collar workers (n=981).	Longitudinal. Web-based baseline survey and SA enquired by text message monthly for 1 year.	Pain intensity, pain duration, painful body sites and pain interference with physical and social activities.	Self-reported number of days on sick leave due to musculoskeletal pain during the last month.	Age, gender, BMI, occupation, smoking, alcohol intake, physical activity, pain characteristics, pain interference.	Latent class growth analysis, multinomial regression analysis.	Four SA trajectories were identified (no SA 76%, few days-increasing 19%, some days-decreasing 3%, some days-increasing 2%). Physical exertion at work, regular smoking, higher number of pain site and pain interference, longer pain duration and low-back pain intensity were associated with the increasing trajectories.
Rysstad et al. 2022	Norwegian 18–67-year-old employees on sick leave based on a musculoskeletal diagnosis (n=549).	Longitudinal. Web-based baseline survey and register based SA data from 2018 to 2019.	Pain intensity, multisite pain.	Number of SA days per month for 1 year.	Age, gender, education level, prior SA, return-to-work expectation, workability, self-perceived health.	Group-based trajectory analysis, multinomial logistic regression analysis.	Six SA trajectories were identified (fast decrease 27%, moderate decrease 22%, slow decrease 12%, U-shape 7%, persistent moderate 13%, persistent high 18%). Multisite pain was associated with the persistent moderate-trajectory. Pain intensity was not associated with trajectory membership after adjusting for the other predictor variables.

4 AIMS OF THE STUDY

The main aim of this dissertation is to examine the associations between life-course socioeconomic circumstances and pain, as well as the associations between pain and subsequent SA, using register-based data. A specific aim is to focus on pain and concurrent mental health, and finally on SA trajectories among young and early midlife employees with pain. The study population was an occupational cohort of employees of the City of Helsinki who were 19–39 years old in 2017. Figure 3 presents a simplified framework of the dissertation study and the suggested interrelationships between the central variables.

The dissertation study consisted of three substudies, all with specific aims:

I. To estimate the prevalence of pain, particularly chronic pain, and how socioeconomic circumstances in childhood and adulthood are associated with chronic pain and chronic pain-related disability among young and early midlife employees.

II. To examine how chronic and multisite pain are associated with subsequent SA among young and early midlife employees, and to study the role of pain and concurrent mental health in the association with SA.

III. To identify distinct long-term SA trajectories among young and early midlife employees with pain, and to examine whether pain, and work-related and lifestyle factors are associated with these trajectories.

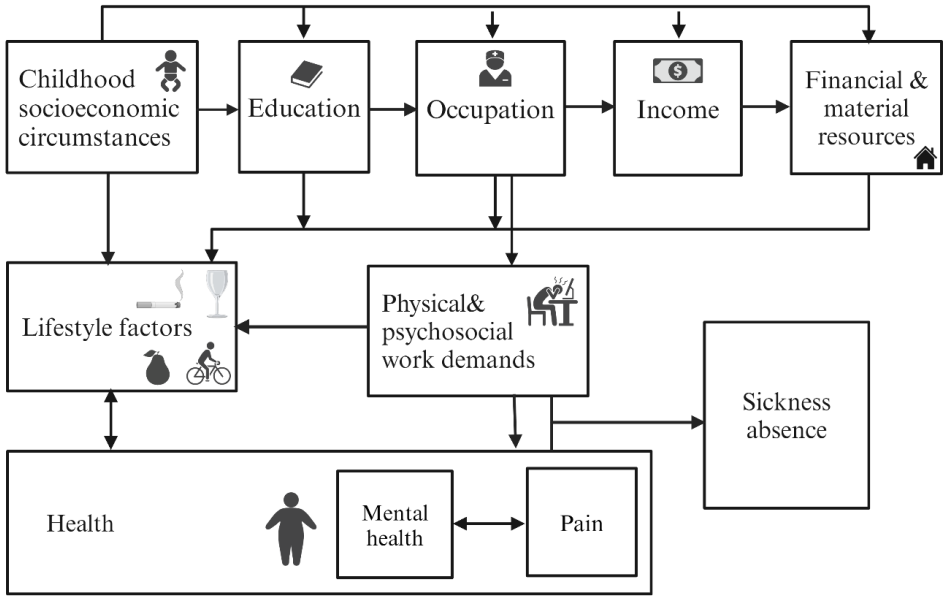


Figure 3 Simplified framework of the study and suggested interrelationships between central variables. Illustration by Pi Fagerlund.

5 DATA AND METHODS

5.1 STUDY POPULATION AND DATA

This dissertation study was based on survey data collected in the autumn of 2017 on 19–39-year-old employees of the City of Helsinki, linked to prospective personnel-register SA data and national register data on sickness allowance payments from Kela. The data on SA and sickness allowance payments for Substudy II was collected one year after the day the questionnaire was returned. The data on sickness allowance payments for Substudy III were collected from 1 January 2018 to 31 March 2020.

5.1.1 DATA COLLECTION

The survey data were collected as part of the Helsinki Health Study, a longitudinal cohort study that has followed the health and working conditions of employees of the City of Helsinki since 2000 through repeated surveys (Lahelma et al., 2013). At the very beginning, the Helsinki Health Study focused on employees aged 40 and older at baseline, and 2017 was the first time that employees aged below 40 years were invited to participate (Lahelma et al., 2013; Lallukka, Pietiläinen, et al., 2020).

The target population of this younger cohort of the Helsinki Health Study were employees of the City of Helsinki who were born in 1978 or later and who had had a working contract of over four months for at least 50 per cent regular working hours per week when the survey was conducted. These criteria aimed to exclude temporary employees and those with few working hours. The final target population consisted of 11,459 employees (Lallukka et al., 2020).

Employees in the target population were invited to fill in an online questionnaire, the link to which was sent to their office email in autumn 2017. A paper questionnaire was sent by post to those who did not have an office email or did not respond to the online questionnaire. Employees who did not respond despite reminders were selected for phone interviews if their phone number was available. The final response rate was 51 per cent (5898 employees). The responses collected through online questionnaires accounted for 58 per cent, mailed questionnaires for 29 per cent, and telephone interviews for 13 per cent of the responses (Lallukka, Pietiläinen, et al., 2020). Of all the respondents, 76 per cent were women, which corresponds to the gender proportion in the Finnish municipal sector. The questionnaire collected information on a broad range of sociodemographic and socioeconomic factors, health, pain, lifestyle, work-related factors, and register linkage consent. Of the respondents, 83 per cent of the women and 80 per cent of the men consented to register linkage, which enabled linking their

questionnaire data to information on SA from the personnel register of the City of Helsinki, as well as to Kela's data on sickness allowance payments.

5.2 MEASUREMENTS AND VARIABLES USED IN SUBSTUDIES (I)-(III)

5.2.1 PAIN

The questionnaire contained questions on current pain status. The first two pain-related questions aimed to determine the prevalence of pain and its duration. The first question was 'Are you suffering from any pains or aches right now?' and the response alternatives were 'no' or 'yes'. Respondents reporting current pain were asked whether the pain had lasted for less or more than three months. Pain that lasted three months or longer was defined as chronic pain in line with the definition by the International Association for the Study of Pain (Raja et al., 2020). Pain that lasted less than three months was defined as acute.

Substudy I considered the degree of disability related to chronic pain, and the respondents reporting current chronic pain were invited to complete the Chronic Pain Grade Questionnaire (CPG), which is a validated tool for the assessment of chronic pain-related disability (Korff et al., 1992). The CPG consists of seven questions on the intensity, persistence, and interference of chronic pain with daily activities; working capacity; and social life during the past six months. A disability score ranging from zero to six was calculated on the basis of the employees' responses to the seven questions. The disability score was further dichotomized into chronic pain with a low disability level (CPLD) (score 0–2) and chronic pain with a high disability level (CPHD) (score of 3–6)(Korff et al., 1992).

Substudies II and III investigated the number of pain sites. Respondents reporting current pain were also asked 'Where do you feel the pain?'. The response alternatives were five specified sites on the body (neck and shoulders, lower back, upper extremities, lower extremities, face, or head) and 'elsewhere'. Each of the six response alternatives was considered one pain site. A missing answer was interpreted as no pain in that body site. A summed score for the number of painful body sites was calculated and dichotomized as single-site pain or multisite pain (≥2 pain sites), as in previous studies (Haukka et al., 2015, 2017; Shiri et al., 2021).

5.2.2 SICKNESS ABSENCE

Sickness absence was the outcome in Substudies II and III. Longitudinal register data on the total number of SA days during employment for the City of Helsinki were obtained from the employer's personnel register. During the time when SA data was collected, SA certification practices at the City of

Helsinki changed. From the beginning of the study period in 2017 and until the beginning of 2019, supervisors could approve one to three days of self-certified SA. From SA days four to seven, the employer required an SA certificate issued by a nurse, physiotherapist, or physician. All SA spells exceeding seven days required a certificate issued by a physician. From the beginning of 2019, a new practice allowed supervisors to approve self-certified SA for up to five work days and two days off after this. Days six to seven could be certified by a nurse, physiotherapist, or physician, but all SA exceeding seven days still required a sickness absence certificate issued by a physician.

Data on sickness allowance payments (reflecting SA spells exceeding ten working days) were obtained from a national register maintained by Kela, and these data were independent of the employer at the time of data collection.

For Substudy II, the SA data were collected prospectively for one year from the day the questionnaire was returned. The total number of SA days and long-term SA days were analysed separately, as the latter indicate a particularly high risk of disability pension (Salonen et al., 2020). In this dissertation, long-term SA is defined as SA exceeding ten working days, in other words SA compensated by sickness allowance from Kela, which was also the source of these data.

In Substudy III, the outcome was based on longitudinal data from Kela reflecting long-term SA during a 27-month period between 1 January 2018–31 March 2020. The follow-up period was split into six 4.5-month observation intervals to form a meaningful number of time points for the trajectory analyses. The outcome used for the logistic group-based trajectory modelling was the dichotomy variable for each observation period (yes/no), showing whether or not the employees had been on long-term SA during the observation period in question.

5.2.1 SOCIOECONOMIC FACTORS

The focus of Study I was the association between childhood and current SEP and pain. The childhood SEP indicators considered were parental education level and childhood economic difficulties. Respondents could report the highest education level of each parent on a four-level scale (1: middle school or less; 2: vocational school, college or equivalent; 3: upper secondary school; 4: university degree). The highest education level of either parent was chosen for further analyses. Childhood economic difficulties were elicited by a 'yes/no' question on whether or not the respondent had experienced economic difficulties in the family before the age of 16 years.

Current SEP was assessed by the respondent's own education level, occupational class, housing tenure, household income, household wealth, and current economic difficulties. The respondents' highest education level was divided into high (master's degree or higher), intermediate (bachelor's degree) or low (upper secondary school or lower). The employee

register of the City of Helsinki classified employees as professionals (such as teachers and physicians), semi-professionals (such as registered nurses), routine non-manual workers (such as practical nurses, childminders and clerical employees) and manual workers (such as construction workers and cleaners). On the basis of housing tenure status, the employees were divided into owner-occupiers, renters or other. Household income was equivalized to household size by dividing the typical monthly net household income (enquired on a ten-point scale) by a weight factor according to the modified OECD equivalent scale: the respondents received a value of 1.0, other adults 0.5 and children 0.3, and these values were added together (Hagenaars et al., 1994). The equivalized household income was further divided into gender-specific quartiles that were combined into a common variable for both genders. Household wealth was reported on a ten-point scale ranging from <€10,000 to >€900,000 based on the distribution of the responses, and to obtain similar group sizes, the employees were classified into a high (⩾€100,000), intermediate (€10,000–€99,999) or low (<€10,000) wealth category. Current economic difficulties were elicited by two questions: (a) 'How often do you have enough money to afford the kind of food or clothing you/your family should have?' and (b) 'How much difficulty do you have in meeting the payment of bills?'. Response categories ranged from 'never' to 'always' and 'very great' to 'very little or none'. A summed score was formed and divided into three categories: no, occasional, and frequent difficulties (Pearlin & Schooler, 1978).

5.2.2 MENTAL HEALTH

Substudy I considered mental health a covariate. For this purpose, mental health was scored on the basis of the 12-item General Health Questionnaire (GHQ-12) and dichotomised into not having (0–2 points) and having mental health problems (⩾3 points) (Goldberg et al., 1997). The GHQ-12 questionnaire was unavailable when Substudy II was conducted, and so the RAND-36 emotional well-being subscale was used to identify mental symptoms. This subscale consists of five questions on mental well-being during the last four weeks ('Have you been a very nervous person?', 'Have you felt so down in the dumps that nothing could cheer you up?', 'Have you felt calm and peaceful?', 'Have you felt downhearted and blue?', and 'Have you been a happy person?') (Aalto & Aro, 1999; Hays & Morales, 2001). Symptoms were reported on a six-level Likert scale ranging from 'none of the time' to 'all of the time'. A summed score (range 0–100 points) was calculated and dichotomized with the median value (76.0 points) as the cut-off (Aalto & Aro , 1999). Respondents with a score below or equal to the median were defined as having poorer mental health, and respondents with a score above the median as having better mental health. This cut-off was chosen to enable a dichotomized stratification of pain variables by mental health, while maintaining large enough group sizes for further analyses.

5.2.3 OCCUPATIONAL WORKLOAD

Physical and mental workload were analysed as exposure variables in Substudy III. Both self-perceived physical and mental workload were elicited by the question 'What is your job like?' (physically/mentally). The response options were on a five-point Likert scale from very light to very strenuous. High physical workload was defined as physically quite or very strenuous work. High mental workload was defined as a very strenuous mental workload. A tighter cut-off level was chosen for defining mental workload as high because a disproportionately large share of the employees reported a mentally quite or very strenuous workload.

5.2.4 LIFESTYLE FACTORS

Lifestyle factors were considered covariates in Substudies I and II, and exposure variables in Substudy III. The factors included were alcohol consumption, nicotine use and smoking, vegetable consumption, leisure-time physical activity, BMI, and insomnia, all of which were self-reported.

Substudy III used different variables reflecting alcohol consumption and smoking than Substudies I and II, as the variables in Substudy III were restricted to those that were elicited in the phone interviews. The frequency of binge drinking, defined as consumption of ≥6 servings of alcohol on one occasion, was elicited in Substudies I and II on a scale ranging from 'never' to 'every day or almost every day'. The variable reflecting binge drinking was classified as binge drinking 'weekly or more often' and 'less than weekly'. In Substudy III, however, the question 'Which of the following options best describes your current beer, wine and spirits consumption?' was used to classify respondents as 'twice weekly or more frequently' and 'less than twice weekly' consumers of alcohol. Nicotine use (smoking, vaping or snuff) was classified as current use (daily or occasionally) or non-use (quit or never used) in Substudies I and II. However, most nicotine users smoked. Substudy III only considered smoking, but the frequency of use classification was identical to that in the two previous studies. The frequency of vegetable intake was enquired on a Likert scale ranging from 'not during the past four weeks' to 'twice daily or more' and dichotomized as 'daily' or 'more seldom'. Insomnia was measured using the Jenkins Sleep Questionnaire and defined as having at least one of four enquired symptoms of sleep difficulties on more than 14 nights per month (Jenkins et al., 1988). Leisure-time physical activity (LTPA) was measured in metabolic equivalent hours (METh) per week, on the basis of the self-reported weekly amount and intensity of LTPA. Respondents reporting LTPA equivalent to <14 METh/week were classified as having a low activity level. Respondents reporting LTPA corresponding to ≥14 METh/week, but no vigorous exercise, were classified as having an intermediate activity level. Respondents reporting LTPA exceeding 14 METh/week that included at least some vigorous exercise, were classified as having a high activity level (Lahti et al., 2012; Salmela et al., 2020b). BMI was calculated on the basis of

self-reported weight and height and classified as <25 kg/m², 25–29.9 kg/m² or ≥30 kg/m² (World Health Organization Regional Office for Europe, 2022).

5.2.5 SOCIODEMOGRAPHIC FACTORS

Gender was reported and classified as man or woman. Age was calculated on the basis of year of birth and dichotomized as <30 years and 30–39 years for descriptive analyses and adjustment in Substudy I, but Substudies II and III used age as a continuous covariate. Marital status was classified as 'married or cohabiting', and 'other' (unmarried, divorced, or widowed). Respondents who either themselves or at least one parent was born outside Finland were classified as having an immigrant background.

5.3 STATISTICAL ANALYSES

5.3.1 MAIN ANALYSES

In Substudy I, the distributions of exposure variables, outcome variables and covariates were assessed by gender, and the distributions of exposure variables and covariates were assessed by pain status using crosstabulation and Pearson's Chi-square test. The associations of both childhood and adulthood socioeconomic indicators with pain status were assessed using multinomial logistic regression analysis. Three regression models were analysed, in which Model 1 was adjusted for age and gender, and Model 2 was adjusted for age, gender, and childhood socioeconomic factors. Model 3 was adjusted for age, gender, childhood socioeconomic factors, marital status, immigrant background, working status, lifestyle factors, and mental health.

In Substudy II, the distributions of the exposure variables, outcome variables and covariates were first assessed using crosstabulation and Pearson's Chi-square test. The data from the personnel register on the total number of SA days did not account for whether the employment had ended before the end of the one-year follow-up. Thus, these data were equivalized to account for the duration of employment during the follow up and are hereafter presented as SA days per person-year.

Synergistic interaction is when two co-occurring exposures have an association with the outcome that deviates from being purely additive. Synergistic interaction between pain variables and mental health and between pain variables and gender was analysed using an Excel formula published by Andersson et al. (Andersson et al., 2005). The exposure variables were chronic pain, multisite pain, and mental health, and three variables formed by stratifying the variables chronic pain, multisite pain, and mental health by each other. Further, the associations of these variables with the total number of SA days and long-term SA days per person-year were assessed by negative

binomial regression analysis using the log link function. Two regression models were analysed, in which Model 1 was adjusted for age and gender, and Model 2 was adjusted for age, gender, marital status, education level, binge drinking, nicotine use, physical activity, and BMI.

In Substudy III, long-term SA data from Kela was first used to model long-term SA trajectories for a follow-up period of 27 months (1 January 2018–31 March 2020) using direct observation of the data and group-based trajectory modelling (GBTM), which identifies latent subgroups of individuals that share similar trajectories of an outcome over time (Nagin, 2014). Employees who had no long-term SA during the 27 months formed a *no LTSA* trajectory, based on the observed data. Those who experienced long-term SA during the follow up were assigned to a long-term SA trajectory based on the posterior probability of belonging to that group. The best-fitting model was chosen on the basis of a set of model fit indices (Bayesian Information Criterion, Akaike's Information Criterion and entropy) and the appropriateness of the model in relation to the outcome (Appendix to Substudy III, Supplementary Table 3). The association between trajectory group membership and the exposure variables comprising pain characteristics, lifestyle, and occupational factors was assessed by multinomial logistic regression analysis and presented as average marginal effects (AMEs). The AME is presented in percentage points and interpreted as the average difference in probability, compared to the reference group, of belonging to the trajectory group in question. Two regression models were analysed, in which Model 1 was adjusted for age and gender, and Model 2 was adjusted for age, gender, chronic pain, and multisite pain. Table 4 summarizes the statistical methods used in the three substudies.

5.3.2 ADDITIONAL AND SENSITIVITY ANALYSES

In Substudy I, gender interaction analyses using an interaction term were performed to assess the appropriateness of performing pooled analyses combining both genders. Correlation and multicollinearity analyses, the results of which were presented as Spearman's correlation coefficients and variance influence factor coefficients, were also performed and revealed a correlation between indicators reflecting current SEP (Appendix substudy I, Supplementary table I).

In Substudy II, gender-stratified multinomial logistic regression analyses of the association between pain and total SA were conducted, and the synergistic interaction of gender and pain to this association was examined using the Excel formula created by Anderson et al. (Andersson et al., 2005). Further, to control for the representativeness of the main analyses, age- and gender-adjusted multinomial logistic regression analyses were conducted of the association between pain status and mental health for the whole eligible study population, including the phone respondents, who were excluded from

the main analyses due to the unavailability of multiple covariates. Lastly, pain status was cross tabulated by the mean number of long-term SA days during the one-year follow up separately for long-term SA due to psychiatric, musculoskeletal, and other diagnoses.

In Substudy III, the gender distributions of exposure variables and covariates were assessed using cross tabulation and Pearson's Chi-square test. Correlation and multicollinearity were assessed by calculating the Spearman correlation coefficients and estimating the variance influence factors for the exposure variables. To obtain more information about the three identified long-term SA trajectories after the main analyses, the association between two items of the role limitations due to emotional problems-subscale (from the RAND-36 Measure of Health-related Quality of Life) and long-term SA trajectories were analysed (Hays & Morales, 2001). The results were presented as age- and gender adjusted AMEs and their 95 per cent confidence intervals.

5.3.3 MISSING DATA

As the register data on SA was assumed to be complete, issues regarding missing data only concerned the questionnaire data. In all the substudies, if data on an exposure or outcome variable were unavailable, the respondent was excluded from the analyses. However, if the missing data only concerned a covariate, in Substudy I the respondents were assigned to the reference group, as this would not exaggerate the results and maintain a more representative study population. In Substudies II and III, employees with missing covariate data were excluded, except for those with missing data on binge drinking in Substudy II, who made up such a large group (3.6 per cent) that they were retained and made into a separate category. The statistical software used was IBM SPSS 26 and 27 and STATA version 16. In Substudy III, the traj package for STATA was used for GBTM analyses.

5.4 ETHICAL CONSIDERATIONS

The three observational substudies on which this dissertation is based are all part of the Helsinki Health Study. The Helsinki Health Study's study plan received a favourable statement from the ethical board of the Faculty of Medicine at the University of Helsinki in February 2017 (decision nr. 01/2017) and an updated approval by the City of Helsinki in April 2017 (decision nr. HEL 2017-004490). The City of Helsinki issued the research permit. The ethical aspects of the study were in line with the Declaration of Helsinki. By participating in the Helsinki Health Study, the respondents agreed to their submitted questionnaire data being used for scientific research purposes, and were aware that the data are handled in accordance with the data protection

statement of the Helsinki Health Study, which can be publicly accessed via the research group's website. The data have been handled with confidentiality within the University of Helsinki's data network and the Finnish Social and Health Data Permit Authority's web environment Kapseli®. Only respondents who had given their informed consent to register linkage were included in Substudies II and III, which used register data. The participants were permitted to withdraw from the Helsinki Health Study at any point.

Table 4. Description of the data and main statistical methods used in substudies I-III.

Substudy	I	II	III
Target population	- All respondents (n=5898)	- Respondents who permitted register linkage (n=4864)	- Respondents who reported pain at baseline and permitted register linkage (n=2009)
Excluded respondents	- Phone respondents (n=787) - Missing exposure (n=351) - Missing outcome (n=64) - Missing covariates (n=13)	-Phone respondents (n=651) - Not working, unknown employment status (n=86) - Missing exposure (n=97) - Missing covariates (n=119)	-Not working, unknown employment status (n=230) Missing exposure (n=86) - Missing covariates (n=8)
Study population	N=4683, 80% women	N=3911, 80% women	N=1685, 81% women
Outcome	- Acute pain - Chronic pain, low-disability level - Chronic pain, high disability level	- Total sickness absence days during 1 year - Long-term SA days (>10 working days) during 1 year	- Long-term SA trajectories based on registered long-term SA days during 27-month follow-up
Main exposures	- Parental education level - Childhood economic difficulties - Own education level - Occupation - Income - Household wealth - Housing tenure - Current economic difficulties	- Chronic pain - Multisite pain - Mental health (RAND 36 emotional well-being subscale score) + all combinations of these variables	- Chronic pain - Multisite pain - Alcohol use (frequency) - Smoking - Vegetable consumption - BMI - Occupation - Physical workload - Mental workload
Covariates adjusted for	- Age - Gender - Marital status - Immigrant background - Working status - Binge drinking - Nicotine use - Physical activity - BMI - Insomnia - Mental health (GHQ 12)	- Age - Gender - Marital status - Education level - Binge drinking - Nicotine use - Physical activity - BMI	- Age - Gender
Statistical methods	- Multinomial logistic regression analysis	- Negative binomial regression analysis	- Group-based trajectory modelling -Multinomial logistic regression analysis

6 RESULTS

6.1 SOCIO-ECONOMIC CIRCUMSTANCES AND THE ASSOCIATION WITH PAIN AND PAIN RELATED DISABILITY (I)

Substudy I aimed to examine the associations between childhood and current socioeconomic circumstances and acute pain and chronic pain. Chronic pain conditions contributing to CPLD and CPHD were analysed separately. Current pain was reported by 42.2 per cent of the 4683 included 19–39-year-old employees. Women accounted for 79.8 per cent of the study population, and 44 per cent of them reported current pain, in comparison to 35 per cent of the men. Acute pain was reported by 22.5 per cent and chronic pain by 19.7 per cent. CPLD was reported by 15.4 per cent and CPHD by 4.3 per cent of the respondents (Table 5). Employees with childhood or current socioeconomic disadvantage were overrepresented among those reporting acute or chronic pain, particularly CPHD. For example, employees with a low education level accounted for 33.5 per cent of all respondents, but 52.0 per cent of those reporting CPHD. The prevalence of mental health problems, as measured by the GHQ-12 questionnaire, was 35.0 per cent in the total study population but as high as 63.5 per cent in the group reporting CPHD ($p<0.001$). Obesity and nicotine use were also more common ($p<0.001$) in the group reporting CPHD. Respondents with a high level of LTPA were underrepresented in all the pain categories ($p<0.001$) (Table 5).

The multinomial logistic regression analyses results showed that all the considered indicators of childhood and current SEP were associated with acute and chronic pain (Table 6). The associations between socioeconomic circumstances and pain were generally stronger for CPHD than CPLD and acute pain. There was also a socioeconomic gradient in the strength of the associations. Parental education level was associated with acute and chronic pain, and childhood economic difficulties were also associated with chronic pain after adjustment for age, gender, lifestyle factors, mental health, and mutual adjustment of the measures of childhood socioeconomic circumstances. In comparison to the group with the highest parental education level, a level corresponding to elementary school was associated with CPHD (OR 1.80, 95% CI 1.10–2.96), as well as with acute pain (OR 1.57, 95% CI 1.21–2.05). A similar association was observed for reporting frequent childhood economic difficulties and current CPHD (OR 1.86, 95% CI 1.35–2.57).

Current socioeconomic circumstances were associated with both acute and chronic pain and the level of chronic pain-related disability. However the strength of the association varied according to the SEP indicator and pain measure considered. After adjustment for age, gender, childhood socioeconomic circumstances, lifestyle factors, and mental health, the

respondent's current education level remained associated with both acute and chronic pain. Associations were also observed with occupational class, housing tenure status, wealth, and subjective economic difficulties. The strongest associations were between CPHD and the participants' own low education level, manual work, and frequent economic difficulties. However, although income level was less clearly associated with pain after adjustments, the association between belonging to the lowest income quartile and reporting CPHD remained significant (OR 2.41, 95% CI 1.44–4.02) after adjustments

Table 5. *Participant characteristics by gender(n=4683) (substudy I). Adapted from Fagerlund et al. 2023 substudy (I).*

	Men (%)	Women (%)	Total (%)	Total (n)	p-value
Pain outcome					<0.001
No pain	65	55.9	57.8	2706	
Acute pain	17.2	23.9	22.5	1055	
CPLD	14.9	15.6	15.4	722	
CPHD	2.9	4.6	4.3	200	
Parental education level					0.080
Higher education	45.8	42.5	43.2	2023	
Upper secondary school	13.2	12.4	12.5	587	
Vocational school	31.5	35.9	35.0	1641	
Elementary school	9.5	9.2	9.2	432	
Childhood economic difficulties					0.139
No	76.6	78.8	78.3	3668	
Yes	23.4	21.2	21.7	1015	
Own education level					<0.001
High	28.5	29.8	29.5	1383	
Intermediate	29.4	38.9	37.0	1732	
Low	42.1	31.3	33.5	1568	
Occupational class					<0.001
Professionals	30.8	26.9	27.7	1298	
Semi-professionals	29.9	43	40.3	1888	
Routine non-manual empolyees	24.8	27.3	26.8	1256	
Manual workers	14.5	2.8	5.1	241	
Housing tenure					0.569
Owner-occupier	43.6	42.6	42.8	2004	
Renter (or other)	56.4	57.4	57.2	2679	
Income level					0.008
4th quartile (highest)	24.3	24.1	24.1	1129	
3rd quartile	29.4	25.4	26.2	1227	
2nd quartile	20.2	24.9	24	1123	
1st quartile (lowest)	26.2	25.6	25.7	1204	
Wealth (€)					<0.001
≥100k	24.5	24.5	24.5	1148	
10k-99 999	45.9	39	40.4	1893	
<10k	29.6	36.5	35.1	1642	
Economic difficulties					0.057
No difficulties	48	45	45.6	2136	
Occasional difficulties	43.5	44.2	44.1	2063	
Frequent difficulties	8.4	10.8	10.3	484	
Age					0.004
<30 years	28.1	32.9	31.9	1496	
≥30 years	71.9	67.1	68.1	3187	
Immigrant background					0.034
No	89.8	91.9	91.5	4284	
Yes	10.2	8.1	8.5	399	
Marital status					<0.001
Married or co-habiting	71.4	65.2	66.5	3112	
Other or missing	28.6	34.8	33.5	1571	
Employment status					<0.001
Working	97.1	88.2	90.0	4216	

Not working	2.9	11.8	10.0	467	
Binge drinking					<0.001
No binge or missing	83.8	96.2	93.7	4388	
Weekly or more frequently	16.2	3.8	6.3	295	
Nicotine use					<0.001
No use or missing	60.7	75.4	72.4	3392	
Daily or sporadically	39.3	24.6	27.6	1291	
Physical activity					<0.001
High or missing	70.2	59.6	61.7	2891	
Intermediate	19.7	31.3	28.9	1355	
Low	10.0	9.2	9.3	437	
BMI					0.686
<30 kg/m2 or missing	86.2	85.7	85.8	4016	
≥30 kg/m2	13.8	14.3	14.2	667	
Insomnia					<0.001
No insomnia or missing	76.6	66.9	68.8	3223	
Insomnia	23.4	33.1	31.2	1460	
Mental health (GHQ)					<0.001
No mental health problems or missing	73.2	62.9	65	3043	
Mental health problems	26.8	37.1	35.0	1640	

CPLD=chronic pain with low disability level, CPHD= chronic pain with high disability level, BMI= body mass index, GHQ= General Health Questionnaire, p-value calculated by Pearsons Chi-squared test.

Table 6. *Associations of childhood and current socio-economic circumstances with acute pain, chronic pain with low disability level and chronic pain with high disability level, based on multinomial logistic regression analyses. Reference group: no pain (OR 1.00). Model 1 adjusted for age and gender, Model 2 adjusted for age, gender, immigrant background, marital status, working status, binge drinking, nicotine use, leisure-time physical activity, body mass index, insomnia, and mental health. CPLD=chronic pain with low disability level, CPHD= chronic pain with high disability level. OR=odds ratio, CI=confidence interval. Adapted from Fagerlund et al. 2023 (substudy I).*

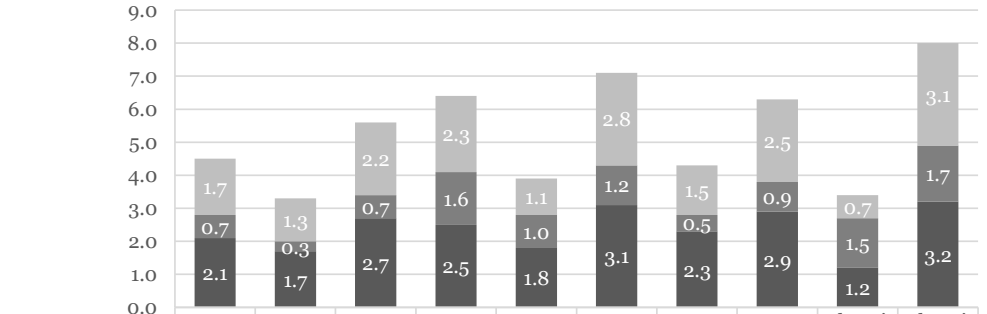
	Model 1			**Model 2**		
	Acute pain	**CPLD**	**CPHD**	**Acute pain**	**CPLD**	**CPHD**
	OR (95 % CI)	OR (95 % CI)	OR (95 % CI)	OR (95 % CI)	OR (95 % CI)	OR (95 % CI)
Parental education level						
Higher education	1	1	1	1	1	1
Upper secondary school	1.15 (0.91–1.44)	0.97 (0.75–1.27)	1.34 (0.84–2.14)	1.14 (0.91–1.45)	0.94 (0.72–1.24)	1.27 (0.79–2.06)
Vocational school	1.31 (1.11–1.54)	1.02 (0.85–1.23)	1.43 (1.03–2.00)	1.28 (1.08–1.52)	0.95 (0.78–1.15)	1.32 (0.93–1.87)
Elementary school	1.58 (1.22–2.03)	1.34 (1.00–1.79)	1.98 (1.23–3.19)	1.57 (1.21–2.05)	1.25 (0.93–1.69)	1.80 (1.10–2.96)
Childhood economic difficulties						
No	1	1	1	1	1	1
Yes	1.34 (1.13–1.59)	1.65 (1.37–2.00)	2.62 (1.93–3.55)	1.17 (0.97–1.40)	1.45 (1.19–1.77)	1.86 (1.35–2.57)
Own education level						
High	1	1	1	1	1	1
Intermediate	1.30 (1.08–1.56)	1.25 (1.01–1.53)	1.60 (1.05–2.45)	1.25 (1.04–1.51)	1.23 (0.99–1.52)	1.57 (1.01–2.44)
Low	1.75 (1.45–2.11)	1.59 (1.28–1.97)	4.00 (2.68–5.96)	1.59 (1.29–1.95)	1.44 (1.13–1.82)	3.38 (2.18–5.24)
Occupational class						
Professionals	1	1	1	1	1	1
Semi-professionals	1.17 (0.97–1.40)	1.07 (0.87–1.31)	1.55 (1.03–2.33)	1.12 (0.93–1.35)	1.03 (0.83–1.28)	1.47 (0.96–2.24)
Routine non-manual empolyees	1.47 (1.21–1.79)	1.25 (1.00–1.57)	2.60 (1.72–3.93)	1.35 (1.09–1.67)	1.15 (0.91–1.47)	2.21 (1.41–3.45)
Manual workers	1.60 (1.12–2.28)	1.60 (1.09–2.36)	3.94 (2.09–7.44)	1.52 (1.05–2.20)	1.52 (1.01–2.27)	3.75 (1.92–7.34)
Housing tenure						
Owner occupiers	1	1	1	1	1	1
Renters or others	1.27 (1.10–1.48)	1.07 (0.91–1.28)	1.85 (1.35–2.52)	1.21 (1.03–1.42)	0.97 (0.81–1.17)	1.40 (1.00–1.96)
Income level						
4th quartile	1	1	1	1	1	1
3rd quartile	1.04 (0.85–1.28)	1.11 (0.88–1.41)	1.35 (0.85–2.16)	1.01 (0.82–1.25)	1.06 (0.83–1.35)	1.24 (0.77–2.01)
2nd quartile	1.25 (1.02–1.53)	1.22 (0.96–1.55)	1.48 (0.93–2.37)	1.20 (0.96–1.50)	1.08 (0.83–1.40)	1.26 (0.76–2.09)
1st quartile	1.11 (0.90–1.36)	1.31 (1.04–1.66)	2.75 (1.80–4.21)	1.10 (0.85–1.41)	1.15 (0.87–1.54)	2.41 (1.44–4.02)

Wealth						
≥100k	1	1	1	1	1	1
10k-99 999	1.30 (1.08–1.57)	1.38 (1.11–1.71)	1.51 (0.98–2.33)	1.28 (1.06–1.56)	1.34 (1.07–1.68)	1.34 (0.85–2.09)
<10k	1.55 (1.28–1.89)	1.59 (1.27–1.99)	3.20 (2.11–4.85)	1.37 (1.11–1.70)	1.32 (1.03–1.69)	1.94 (1.24–3.05)
Economic dififculties						
No	1	1	1	1	1	1
Occasional	1.43 (1.23–1.66)	1.75 (1.47–2.09)	1.77 (1.26–2.49)	1.33 (1.14–1.55)	1.62 (1.35–1.94)	1.43 (1.01–2.03)
Frequent	1.79 (1.40–2.29)	2.07 (1.56–2.74)	5.44 (3.66–8.08)	1.44 (1.12–1.87)	1.56 (1.16–2.10)	3.07 (2.00–4.70)

6.2 PAIN, CONCURRENT MENTAL HEALTH, AND THE ASSOCIATION WITH SICKNESS ABSENCE (II)

Substudy II sought to examine the association between pain and SA during a one-year follow-up. Pain was classified as acute or chronic, single-site or multisite. The role of concurrent mental health and gender in the associations was focused on separately. The total number of SA days and days of long-term SA (SA days entitling sickness allowance from Kela) were considered separate outcomes.

The study population (n=3911) comprised 19–39-year-old employees. The mean total number of SA days during the one-year follow up was 12.1 days per person-year. The corresponding number of days of long-term SA (entitling sickness allowance) was 4.4 days per person-year. Women; employees aged under 30; those with a low education level, overweight or obesity; and those who did not report their alcohol consumption had a higher number of SA days. Figure 4 presents the distribution of long-term SA days by diagnosis category and pain status.



	all	no pain	acute pain	chronic pain	single site pain	multisite pain	acute single site pain	acute multisite pain	chronic single site pain	chronic multisite pain
Other diagnoses	1.7	1.3	2.2	2.3	1.1	2.8	1.5	2.5	0.7	3.1
M-diagnoses	0.7	0.3	0.7	1.6	1.0	1.2	0.5	0.9	1.5	1.7
F-diagnoses	2.1	1.7	2.7	2.5	1.8	3.1	2.3	2.9	1.2	3.2

Figure 4 Pain status by the mean number of long-term sickness absence days during one year's follow-up. Categories of diagnoses based on the ICD-10 classification system. F diagnoses = ICD-10 F00-F99 mental, behavioural, and neurodevelopmental disorders; M diagnoses = ICD-10 M00-M99 diseases of the musculoskeletal system and connective tissue. Adapted from supplementary table 3 of Fagerlund et al. 2023 (substudy II).

Table 7. *Pain and mental health by gender and by total and long-term sickness absence days during 1- year follow-up. Percentages and mean sickness absence days per person years. Adapted from Fagerlund et al. 2023 (substudy II).*

	Gender			Sickness absence days	
	total	**women**	**men**	**total**	**long-term**
	%	%	%	mean (95% CI)	mean (95% CI)
Pain chronicity					
no pain	57.5	55.8	64.4	9.5 (8.5–10.5)	3.2 (2.4–4.0)
acute	22.7	23.8	17.9	13.9 (12.5–15.3)	5.6 (4.1–7.1)
chronic	19.8	20.4	17.7	17.7 (14.5–20.9)	6.5 (4.9–8.1)
Pain sites					
no pain	57.5	55.8	64.4	9.5 (8.5–10.5)	3.2 (2.4–4.0)
single site	14.4	14.5	13.9	12.4 (10–14.8)	3.9 (2.5–5.3)
multisite	28.1	29.6	21.7	17.3 (15.1–19.6)	7.1 (5.6–8.6)
Mental health					
better	47.1	46.7	48.8	8.7 (7.9–9.5)	2.3 (1.8–2.8)
poorer	52.9	53.3	51.2	15.1 (13.6–16.7)	6.3 (5.2–7.4)
Pain chronicity by pain locations					
no pain	57.5	55.8	64.4	9.5 (8.5–10.5)	3.2 (2.4–4.0)
acute single site	8.0	8.0	7.9	11.0 (8.9–13.1)	4.3 (2.3–6.3)
acute multisite	14.7	15.8	10.0	15.4 (13.6–17.3)	6.3 (4.3–8.4)
chronic single site	6.4	6.5	6.0	14.1 (9.5–18.8)	3.4 (1.5–5.3)
chronic multisite	13.4	13.8	11.7	19.4 (15.1–23.7)	8.0 (5.7–10.2)
Pain chronicity by mental health					
no pain, better mental health	30.3	29.1	35.5	7.0 (6.3–7.7)	1.7 (1.1–2.3)
no pain, poorer mental health	27.2	26.7	29.0	12.3 (10.4–14.2)	4.9 (3.4–6.4)
acute, better mental health	9.7	10.2	7.7	11.9 (10.1–13.8)	3.8 (2.4–5.1)
acute, poorer mental health	13.0	13.6	10.3	15.3 (13.3–17.4)	7.0 (4.6–9.4)
chronic, better mental health	7.1	7.4	5.7	11.7 (8.5–15.0)	2.9 (1.2–4.6)
chronic, poorer mental health	12.8	13.0	11.9	21.0 (16.3–25.7)	8.5 (6.1–10.8)
Pain sites by mental distress					
no pain, better mental health	30.3	29.1	35.5	7.0 (6.3–7.7)	1.7 (1.1–2.3)
no pain, poorer mental health	27.2	26.7	29.0	12.3 (10.4–14.2)	4.9 (3.4–6.4)
single site, better mental health	6.8	6.9	6.5	9.2 (7.0–11.5)	2.2 (0.6–3.7)
single site, poorer mental health	7.6	7.6	7.4	15.2 (11.3–19.2)	5.4 (3.2–7.7)
multisite, better mental health	9.9	10.7	6.9	13.6 (11.2–16.1)	4.3 (2.8–5.7)
multisite, poorer mental health	18.1	18.9	14.8	19.4 (16.2–22.6)	8.7 (6.5–10.9)
CI=confidence interval.					

Current pain was reported by 42.5 per cent of the participants in the study population. Chronic pain was reported by 19.8 per cent, multisite pain by 28.1 per cent, and chronic multisite pain by 13.4 per cent (Table 7). Mental disorders accounted for nearly half of the long-term SA days. The number of long-term SA days attributable to mental, musculoskeletal, and other diagnoses were higher among employees who reported chronic or multisite pain or both than among those who did not report pain (Figure 4).

Reporting any pain in the baseline questionnaire was associated with a higher total number of SA days during the following year (Table 8), after adjustment for age and gender. The association between total SA and acute, chronic,

single-site and multisite pain remained after stratification by concurrent mental health. Reporting chronic or multisite pain was associated with long-term SA. After stratification by concurrent mental health, these associations only remained statistically significant for employees reporting chronic or multisite pain and concurrent poorer mental health, and for employees with multisite pain and better mental health. However, the estimates for the association between pain and long-term SA for employees with better mental health were clearly above one and had broad confidence intervals. Thus, a lack of statistical significance related to small subgroup sizes cannot be ruled out. Adjusting for sociodemographic factors, lifestyle factors and education level attenuated the associations slightly and made the association for multisite pain and concurrent better mental health with long-term SA insignificant.

The associations between pain and total SA were generally stronger among women. Age-adjusted analyses showed a synergistic interaction between female gender and having multisite pain in relation to total SA (synergy index 1.80 [95% CI 1.27–2.54]), meaning that the combined effect of being a woman and having multisite pain on the risk of SA was greater than their added effect (Appendix, Substudy II, Supplementary Table 1). A borderline statistically significant synergistic interaction between chronic pain and poorer mental health in relation to total SA was observed (synergy index 1.38 [95% CI 0.99–1.91]).

Table 8. *Associations between pain chronicity, pain sites, poorer mental health and their combinations with sickness absence (SA) measured as the total number of sickness absence days and long-term sickness absence days (spells >10 working days) per person years during a 1-year follow-up. Model 1 adjusted for age (continuous) and gender. Model 2 adjusted for age (continuous), gender, marital status, education level, binge drinking, nicotine use, physical activity and BMI (continuous) N=3911. SA=sickness absence, RR=risk ratio, CI=confidence interval. Adapted from Fagerlund et al. 2023 (substudy II).*

	Total SA days			**Long-term SA days**	
	Model 1	**Model 2**	**Synergy index (SI)**	**Model 1**	**Model 2**
	RR (95% CI)	RR (95% CI)	SI (95% CI)	RR (95% CI)	RR (95% CI)
Pain chronicity					
no pain	1.00	1.00		1.00	1.00
acute	1.45 (1.28–1.63)	1.36 (1.21–1.53)		1.71 (0.93–3.16)	1.70 (0.92–3.15)
chronic	1.87 (1.64–2.12)	1.66 (1.47–1.89)		2.19 (1.13–4.21)	1.96 (1.01–3.79)
Pain sites					
no pain	1.00	1.00		1.00	1.00
single site	1.32 (1.14–1.52)	1.28 (1.11–1.47)		1.19 (0.57–2.46)	1.14 (0.54–2.40)
multisite	1.81 (1.62–2.02)	1.62 (1.44–1.81)		2.34 (1.31–4.16)	2.19 (1.22–3.90)
Mental health					
better	1.00	1.00		1.00	1.00
poorer	1.70 (1.54–1.87)	1.63 (1.48–1.8)		2.81 (1.71–4.60)	2.73 (1.65–4.54)
Pain chronicity by pain sites					
no pain	1.00	1.00		1.00	1.00
acute single site	1.17 (0.97–1.40)	1.16 (0.97–1.39)		1.26 (0.50–3.21)	1.33 (0.51–3.43)
acute multisite	1.60 (1.39–1.84)	1.47 (1.28–1.69)		1.97 (0.95–4.05)	1.90 (0.92–3.93)
chronic single site	1.51 (1.23–1.84)	1.43 (1.17–1.75)		1.09 (0.39–3.04)	0.91 (0.32–2.59)
chronic multisite	2.05 (1.77–2.37)	1.78 (1.54–2.06)	0.95 (0.63–1.42)	2.76 (1.29–5.93)	2.51 (1.17–5.42)
Pain chronicity by mental health					
no pain, better mental health	1.00	1.00		1.00	1.00
no pain, poorer mental health	1.69 (1.49–1.92)	1.66 (1.47–1.89)		2.95 (1.55–5.63)	2.73 (1.39–5.37)
acute, better mental health	1.62 (1.36–1.93)	1.55 (1.31–1.85)		2.17 (0.88–5.35)	2.12 (0.86–5.24)
acute, poorer mental health	2.14 (1.82–2.50)	1.94 (1.66–2.27)		4.07 (1.81–9.14)	3.65 (1.59–8.35)
chronic, better mental health	1.69 (1.38–2.07)	1.50 (1.23–1.83)		1.83 (0.65–5.13)	1.20 (0.40–3.59)

chronic, poorer mental health	2.90 (2.47–3.41)	2.58 (2.20–3.02)	1.38 (0.99–1.91)	5.53 (2.42–12.63)	5.04 (2.14–11.87)
Pain sites by mental health					
no pain, better mental health	1.00	1.00		1.00	1.00
no pain, poorer mental health	1.69 (1.49–1.92)	1.66 (1.46–1.88)		2.94 (1.54–5.60)	2.72 (1.38–5.34)
single site, better mental health	1.27 (1.04–1.56)	1.22 (1.00–1.49)		1.20 (0.43–3.39)	1.04 (0.36–2.97)
single site, poorer mental health	2.17 (1.78–2.63)	2.11 (1.74–2.56)		3.27 (1.21–8.87)	3.17 (1.11–9.03)
multisite, better mental health	1.91 (1.61–2.28)	1.75 (1.47–2.08)		2.61 (1.07–6.36)	2.26 (0.91–5.61)
multisite, poorer mental health	2.66 (2.31–3.07)	2.31 (2.00–2.66)	1.03 (0.78–1.36)	5.48 (2.64–11.37)	4.88 (2.3–10.33)

6.3 PAIN CHARACTERISTICS, OCCUPATIONAL AND LIFESTYLE FACTORS ASSOCIATED WITH DISTINCT LONG-TERM SICKNESS ABSENCE TRAJECTORIES (III)

Substudy III aimed to identify distinct trajectories of long-term SA among young and early midlife employees with pain, as well as potential lifestyle and work-related factors associated with these trajectories.

The study population consisted of 19–39-year-old employees (N=1685) who reported current pain at the time of the baseline survey in 2017. Women accounted for 81 per cent of the study population. The best fitting trajectory model identified consisted of three distinct trajectories, of which the largest trajectory group without long-term SA spells (*no LTSA*) comprised 74.5 per cent of the study population and was derived by direct observation of the data. The two other trajectories were identified by GBTM and consisted of employees who had had at least one long-term SA spell during the 27-month follow up (Appendix Substudy III, Supplementary Table 3). The '*decreasing*' long-term SA trajectory comprised 17.7 per cent of the study population and showed an initially high frequency of long-term SA, which declined in the latter half of the follow-up period. The smallest '*increasing*' trajectory comprised 7.7 per cent of the study population (Table 8). For this trajectory, the long-term SA was initially low, but it increased consistently during the follow up (Figure 5).

The analyses of the associations between trajectory groups and pain characteristics, and work-related and lifestyle factors were conducted using multinomial logistic regression analyses (Table 9). The analyses adjusted for age and gender revealed that the employees reporting chronic pain had a five percentage-point lower predicted probability of being assigned to the *no LTSA* trajectory and a four percentage-point higher predicted probability of being assigned to the *decreasing* trajectory than the employees with acute pain. Similarly, the employees reporting multisite pain had a nine percentage-point lower predicted probability of being assigned to the *no LTSA* trajectory and were nine percentage points more likely to be assigned to the *decreasing* trajectory than those with single-site pain. The frequency of alcohol consumption was not associated with trajectory membership. Smokers had a seven percentage-point lower predicted probability of being assigned to the *no LTSA* trajectory and a six percentage-point higher probability of being assigned to the *decreasing* trajectory than non-smokers. The employees with overweight or obesity had a six and eight percentage-point lower predicted probability, respectively, of being assigned to the *no LTSA* trajectory; and a six and eight percentage-point higher predicted probability, respectively, of being assigned to the *decreasing* trajectory than the employees with a BMI<25 kg/m^2.

The employees reporting a physically heavy workload had a five percentage-point lower predicted probability of being assigned to the *decreasing* trajectory. Mental workload was not significantly associated with trajectory membership. Occupation was associated with trajectory membership, in that semi-professional, manual, and routine non-manual workers had an eight percentage-point lower predicted probability of being assigned to the *no LTSA* trajectory as compared to professionals. Also, manual and routine non-manual workers had a nine percentage-point higher predicted probability, and semi-professionals a six percentage-point higher predicted probability of belonging to the *decreasing* trajectory than professionals. No factors were statistically significantly associated with the smallest *increasing* trajectory in the main analyses, but additional sensitivity analyses of the association between two available items from the RAND36 role limitations due to emotional distress subscale, which shows the interference of mental symptoms and daily activities, were associated with both the *decreasing* and *increasing* long-term SA trajectories (Appendix, Substudy III, Supplementary Table 4).

Table 9. *The number and proportions of employees on long-term sickness absence (SA) during each observation period during the 27 month follow up. Values presented separately for each trajectory group and for the full sample. Adapted from substudy III by Fagerlund et al.*

	Total	**No long-term SA**	**Decreasing**	**Increasing**	**p -value***
	n *(%)*	n *(%)*	n *(%)*	n *(%)*	
	1685 *(100)*	1256 *(74)*	299 *(18)*	130 *(8)*	
observation period 1	117 (*6.9*)	0 (*0.0*)	114 (*38.1*)	-	<0.001
observation period 2	113 (*6.7*)	0 (*0.0*)	106 (*35.5*)	-	<0.001
observation period 3	126 (*7.5*)	0 (*0.0*)	117 (*39.1*)	-	<0.001
observation period 4	105 (*6.2*)	0 (*0.0*)	85 (*28.4*)	20 (*15.4*)	0.004
observation period 5	90 (*5.3*)	0 (*0.0*)	18 (*6.0*)	72 (*55.4*)	<0.001
observation period 6	101 (*6.0*)	0 (*0.0*)	12 (*4.0*)	89 (*68.5*)	<0.001
* Pearson's Chi squared, - a cell contains less than ten individuals, SA= sickness absence					

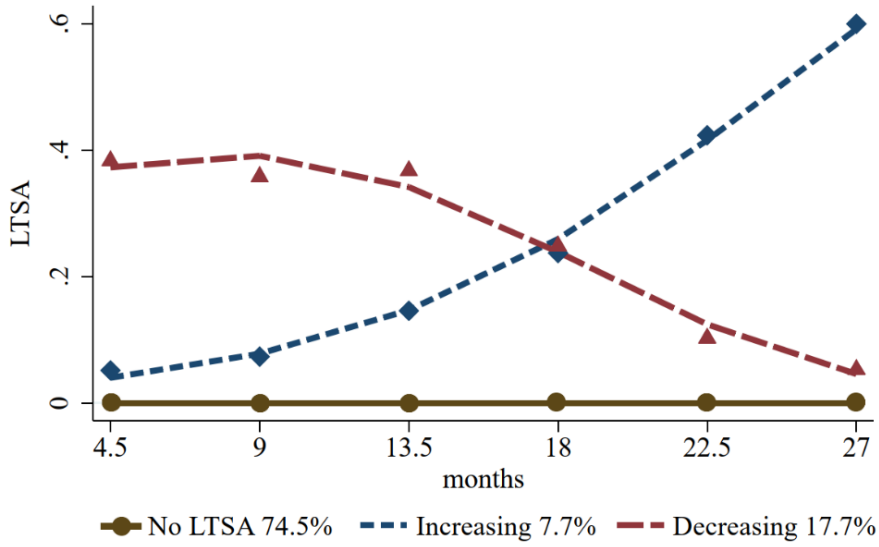


Figure 5 Long-term sickness absence (SA) trajectories among 19–39-year-old employees who reported pain at baseline in 2017 (n=1685). Observation points (1-6) with 4.5-month intervals on the X-axis. The probability of long-term SA for each trajectory group on the Y-axis. Adapted from substudy III by Fagerlund et al.

Table 10. *Associations between pain characteristics, lifestyle factors, occupational factors, and long-term sickness absence trajectories (n=1685). Average marginal effects and their 95% confidence intervals from multinomial logistic regression models. Model 1: adjusted for age and gender, Model 2: adjusted for age, gender, pain chronicity and pain sites, AME=average marginal effect, CI=confidence interval, Ref.= reference group. Adapted from substudy III by Fagerlund et al.*

	Model 1 AME (95% CI)			**Model 2 AME (95% CI)**		
	No LTSA	**Decreasing**	**Increasing**	**No LTSA**	**Decreasing**	**Increasing**
Pain chronicity						
acute	Ref.	Ref.	Ref.			
chronic	-0.05 (-0.09 to 0.00)	0.04 (0.00 to 0.08)	0.01 (-0.02 to 0.03)			
Pain sites						
single site	Ref.	Ref.	Ref.			
multisite	-0.09 (-0.14 to -0.05)	0.09 (0.05 to 0.13)	0.01 (-0.02 to 0.03)			
Alcohol use						
<twice weekly or missing	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
≥ twice weekly	0.03 (-0.03 to 0.10)	-0.03 (-0.08 to 0.03)	0.00 (-0.04 to 0.03)	0.03 (-0.03 to 0.10)	-0.03 (-0.08 to 0.03)	-0.01 (-0.04 to 0.03)
Smoking						
never or stopped	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
daily or sporadically	-0.07 (-0.12 to -0.02)	0.06 (0.02 to 0.11)	0.01 (-0.02 to 0.04)	-0.06 (-0.11 to -0.02)	0.06 (0.02 to 0.1)	0.01 (-0.02 to 0.04)
Vegetable consumption						
≥ daily	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
< daily	-0.06 (-0.1 to -0.01)	0.04 (-0.01 to 0.08)	0.02 (-0.01 to 0.05)	-0.05 (-0.09 to 0.00)	0.03 (-0.01 to 0.07)	0.02 (-0.01 to 0.05)
BMI (kg/m²)						
<25	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
25—29.9	-0.06 (-0.11 to -0.01)	0.06 (0.02 to 0.11)	-0.05 (-0.10 to .00)	0.06 (0.01 to 0.1)	-0.01 (-0.04 to 0.02)	
≥30	-0.08 (-0.14 to -0.02)	0.08 (0.02 to 0.13)	0.01 (-0.03 to 0.05)	-0.07 (-0.13 to -0.01)	0.06 (0.01 to 0.12)	0.01 (-0.03 to 0.04)
Physical workload						
light	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
heavy	-0.05 (-0.1 to -0.01)	0.06 (0.02 to 0.1)	0.00 (-0.03 to 0.02)	-0.04 (-0.08 to 0.00)	0.05 (0.01 to 0.08)	-0.01 (-0.03 to 0.02)
Mental workload						
light	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
heavy	-0.03 (-0.09 to 0.02)	0.03 (-0.01 to 0.08)	0.00 (-0.03 to 0.03)	-0.02 (-0.07 to 0.03)	0.02 (-0.02 to 0.07)	0.00 (-0.03 to 0.03)
Occupational class						
professional	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
semi-professional	-0.08 (-0.13 to -0.03)	0.06 (0.02 to 0.1)	0.02 (-0.02 to 0.05)	-0.08 (-0.13 to -0.02)	0.06 (0.01 to 0.10)	0.02 (-0.02 to 0.05)

manual and routine non-manual workers	-0.08 (-0.13 to -0.02)	0.09 (0.04 to 0.13)	-0.01 (-0.04 to 0.02)	-0.07 (-0.12 to -0.01)	0.08 (0.03 to 0.12)	-0.01 (-0.04 to 0.02)

7 DISCUSSION

7.1 MAIN FINDINGS

The main findings of the study can be summarized as follows:

1. Pain is common among Finnish municipal employees aged under 40 (point prevalence 42% in the current cohort). The point prevalence of pain was higher among women (44%) than among men (35%).

2. The prevalence of pain among young and early midlife employees is socioeconomically patterned with respect to both childhood and current socioeconomic factors. Indicators of low SEP in childhood and adulthood are associated with chronic pain, and the degree of chronic pain-related disability, and the strength of the associations follow a socioeconomic gradient.

3. Reporting pain, particularly chronic pain or multisite pain is associated with having a higher number of total and long-term SA days than the SA days of employees not reporting pain. Reporting chronic pain or multisite pain is associated with long-term SA, particularly among employees with concurrent poorer mental health. Being a woman and having multisite pain means an even higher risk of SA than the added risks of either being a woman or having multisite pain.

4. Most employees (74%) who reported pain at baseline had no long-term SA during a follow up of 27 months. Furthermore, distinct long-term SA trajectories were observed, and eight per cent of the employees with pain belonged to a trajectory with increasing long-term SA and 18 per cent to a trajectory with decreasing long-term SA during the follow up. Employees with chronic pain, multisite pain, obesity, smoking, high physical workload, and manual work were more likely to belong to a trajectory with a pattern of initially high but decreasing long-term SA. The same factors were associated with a lower probability of belonging to a trajectory with no long-term SA. None of the factors in the main analyses were associated with the increasing SA trajectory.

7.1.1 SOCIO-ECONOMIC CIRCUMSTANCES AND PAIN

In the study sample of Substudy I, 44 per cent of the women and 35 per cent of the men reported current pain. The heterogeneity of the measures used to assess pain prevalence in epidemiological studies has been addressed above. Saastamoinen et al., however, used the same point prevalence measures of pain in their cohort of employees aged 40–60. The point prevalence of any pain among the women and the men in their study was 44 per cent and 36 per cent, respectively, which is similar to that in the younger cohort of this study. However, the proportion of chronic pain and disabling chronic pain were higher in their study population of older employees (Saastamoinen et al., 2005).

Chronic pain was reported by 20 per cent of the women and 18 per cent of the men aged 19–39 in this dissertation study. These figures correspond to those of a population-based survey conducted among US adults aged over 18, in which 20.5 per cent of the respondents reported having pain every or almost every day (Yong et al., 2022). The findings of the population-based Health Survey for England in 2017 showed an 18 per cent prevalence of chronic pain among individuals aged 16–34, and this prevalence increased gradually by age group, as it has done in other studies (Public Health England, 2017; Van Hecke et al., 2013). It is thus important to address the risk factors of chronic pain among younger employees, to prevent chronic pain in this age group, but also later in life, not forgetting that the prevalence may be higher among young individuals outside the labour market. The proportion of CPHD in relation to the total prevalence of chronic pain in our cohort was lower than that measured in the population-based Health Survey for England in 2017, which used the same disability scoring. However, their study also included non-employed individuals (Public Health England, 2017).

Substudy I contributed to the knowledge on this topic with updated knowledge on life-course socioeconomic factors as predictors of pain among young and early midlife employees. This study identified clear socioeconomic disparities in the prevalence of pain, including chronic pain and the level of chronic pain-related disability. Socioeconomic inequalities in pain were found in all the socioeconomic indicators considered, although the magnitude of the associations varied across the indicators. This finding also supported the notion that childhood socioeconomic factors are associated with pain in adulthood.

The existing theories that aim to explain the mechanisms by which health inequalities develop along the life course distinguish between structural and developmental mechanisms (Jones et al., 2019). In short, the structural perspective suggests that the accumulation of adversities during the life course, in combination with inadequate coping resources, could contribute to biological ageing, whereas the developmental perspective suggests that negative exposures, particularly during critical or sensitive periods in life such as childhood, may have a more significant cumulative effect on later health

than exposures outside these critical or sensitive periods. The two measures of childhood SEP – parental education level and financial difficulties in childhood – remained associated with chronic pain, particularly CPHD, after adjustments for a range of sociodemographic, lifestyle- and health-related covariates. Parental education level was also associated with acute pain. Previous similar studies in Finland and Portugal have suggested an association between financial difficulties in childhood and fibromyalgia, and between stably low or declining intergenerational education level trajectories and low-back pain. (Lallukka et al., 2014; Lourenço et al., 2017; Varinen et al., 2017b). Another Finnish study demonstrated an association between multiple childhood adversities, among which were childhood financial difficulties, and chronic pain among 40–60-year-old employees (Salonsalmi et al., 2022). Our cross-sectional study design cannot provide explanations for the causal mechanisms that connect childhood socioeconomic factors and pain, but adjustment for adult sociodemographic and lifestyle factors and mental health did not explain the differences either. Adulthood socioeconomic factors were not adjusted for in the analyses, but upward social mobility has previously been associated with better pain outcomes (Lallukka et al., 2014). Given that socioeconomic factors are intergenerationally patterned and socioeconomic factors in adulthood are associated with pain outcomes irrespective of childhood socioeconomic circumstances, factors related to adulthood SEP are likely to be part of this causal pathway.

All the examined adulthood socioeconomic factors remained associated with pain after adjustment for all covariates. The strongest associations observed were between low education level, manual occupation, and frequent economic difficulties, and CPHD. Reported household income was less clearly associated with pain after full adjustments, but belonging to the lowest income quartile was associated with CPHD. Findings from a previous Finnish study using similar measures of pain and socioeconomic factors among older employees made equivalent findings (Saastamoinen et al., 2005). Socioeconomic inequalities in pain thus appear to concern both younger and older employees.

The more disadvantaged the SEP, the stronger were the associations with pain in general, particularly with CPHD. As pain can be a symptom of an underlying injury or disease, the observed socioeconomic gradient in pain is likely to also partly reflect general socioeconomic inequalities in underlying health conditions (Kivimäki et al., 2020). An earlier Swedish study found that manual workers not only reported more long-term illness; they also perceived a higher degree of illness severity (Blank & Diderichsen, 1996). This corresponds to the findings of Substudy I. Factors such as work demands, financial difficulties, smoking, and a weak social network explained part of the socioeconomic differences in perceived illness severity among the men in their study, and most of the differences among the women. We could only adjust for some of these factors in our analyses, and those we did adjust for did not fully explain the socioeconomic differences in

the degree of chronic pain-related disability. Although the study by Blank and Diderichsen examined perceived illness in general, the findings of Substudy I were similar and suggested a 'double suffering' of pain, represented by both higher pain prevalence and more pain-related disability, both of which affect individuals with a lower SEP to a greater extent. Differences in health behaviours are also socioeconomically patterned and known to contribute to socioeconomic differences in health (Petrovic et al., 2018). However, adjustment for alcohol consumption, nicotine use, and BMI, as well as for multiple sociodemographic factors and childhood socioeconomic factors, only partly explained the associations between adulthood SEP and pain in Substudy I.

Pain is likely to interfere more with work when employees have a high physical workload, which could explain part of the excess burden of disabling chronic pain among employees with manual work. The Chronic Pain Grade Questionnaire used to measure chronic pain-related disability in Substudy I contained one item for pain-related limitations at work (Korff et al., 1992). Pain interference with work is thus a part of this outcome measure that might contribute to higher disability scores and stronger associations between pain and CPHD among manual employees. However, similar associations were also found between other indicators of current SEP, such as education level and CPHD.

7.1.2 PAIN, MENTAL HEALTH, AND SICKNESS ABSENCE

Substudy II aimed to fill a gap in the knowledge on the implication of pain for SA specifically among young and midlife employees in the Finnish municipal sector by examining the separate and joint associations of chronic pain, multisite pain, and mental health with SA. Findings from studies conducted in general populations of young adults and studies of older employees have indicated that pain conditions are likely to be common among young and early midlife employees and to also contribute to SA in this group (Murray et al., 2020; Saastamoinen et al., 2009, 2016). The results of this substudy confirm that pain is also associated with SA among Finnish municipal employees below the age of 40. Both chronic and multisite pain were considered, as well as the role of concurrent mental health and gender.

Pain reported at baseline was associated with SA days during the following year, which has also been demonstrated by multiple previous studies, including a similar Finnish study comprising employees aged over 40 (de Fernandes & Burdorf, 2016; Melkevik et al., 2018; Saastamoinen et al., 2009, 2016). Substudy II found that acute and single-site pain conditions were not significantly associated with long-term SA during the following year. Acute or single-site pain are more self-limiting temporary conditions and thus less likely to affect long-term SA rates. However, despite the lack of a statistically significant association with long-term SA, appropriate management of acute

and single-site pain is important to prevent chronic and multisite pain and their associated long-term consequences. Approximately two thirds of the employees who reported chronic pain in Substudy II had multisite pain, and this group with chronic multisite pain had a higher absolute number of long-term SA days during the one-year follow up than the pain-free employees and the employees with other combinations of pain chronicity and numbers of pain sites (Figure 4). The number of pain sites is associated with SA trajectories with more SA and with disability retirement in a dose-response manner (Haukka et al., 2013, 2015; Kamaleri et al., 2009). Pain chronicity and the number of pain sites are thus two different dimensions of pain that indicate an elevated risk of later SA, and when considered simultaneously, could identify employees with a particularly elevated risk of long-term SA.

Kela registers data on SA spells entitling sickness allowance, including the diagnoses entitling the individual to the benefit. Presenteeism – working despite being ill – is a known phenomenon, and the high prevalence of pain in the study population indicates that many employees work despite pain. Although pain does not necessarily lead to long-term SA, it may affect productivity and quality of life. The symptomatology contributing to long-term SA may be complex and involve comorbidities beyond the diagnosis on the sickness certificate. Substudy II focused on symptoms of pain, poorer mental health, and not on diagnosed conditions, to capture as much of the symptom burden in the population as possible.

The interplay between pain and mental symptoms in relation to the risk of SA has been studied previously, but the studies have not really focused on younger employees. Only two identified studies have used register-based SA data (Melkevik et al., 2018; Saastamoinen et al., 2016). Some previous studies have used items such as perceived current work ability, work-limiting health problems, and reduced productivity as measures of work ability (Demyttenaere et al., 2006; Emptage et al., 2005; Shiri et al., 2013). Heterogeneous measures of pain, mental health, SA, and other work ability outcomes complicate comparisons with previous studies. In general, concurrent pain and poorer mental health have both been associated with an increased risk of SA, but the nature of the interplay between the conditions in relation to the risk of SA has been less clear. Melkevik et al. found significant associations between the number of pain sites and depressive symptoms and SA of four weeks or longer when they assessed them separately, but not when the symptoms co-occurred (Melkevik et al., 2018). In Substudy II, the associations with total SA were stronger for those reporting concurrent chronic or multisite pain and poorer mental health, and a borderline significant synergistic interaction between chronic pain and poorer mental health was found in the association with total SA. The study by Melkevik et al. comprised female healthcare workers only, and the authors speculated that the selection of robust individuals who maintain their work ability despite symptoms could explain the lack of association with concurrent symptoms. The Helsinki Health Study cohort is also female dominated, with the majority

of the employees working in the education, social and healthcare sectors (City of Helsinki, 2023). A similar selection mechanism may also be at play here, although concurrent symptoms were clearly associated with any SA and long-term SA in our study population.

Higher pain prevalence and SA rates among women are already known and the gender-stratified associations between pain and SA analysed in Substudy II suggested stronger associations among women (Saastamoinen et al., 2009). The analyses of synergistic interaction indicated that being a woman and having multisite pain posed a higher risk of SA than that expected on the basis of the added independent risks posed by being a woman or experiencing multisite pain. Gender differences in occupations and occupation-related work demands may influence gender differences in the role of pain in SA. A significant share of the City of Helsinki employees work in the healthcare sector, where physical work demands may predispose individuals with pain to SA. This could explain the particularly strong association among women. A previous Finnish study has indicated that women with multisite musculoskeletal pain more often have good work ability than men with similar symptoms, but this conflicts with the findings obtained from Substudy II (Pensola et al., 2016). A study by Mehlum and colleagues (n=217) indicated that women and employees in a lower SEP (measured by occupation) were more likely to report pain aligning with a physician-made diagnosis, and this finding was interpreted as supporting the notion that the excess pain reported by women and employees with a lower SEP is not due to overreporting (Mehlum et al., 2013). The gender differences identified in Substudy II show that it is particularly important to acknowledge the potential consequences of pain at female-dominated workplaces, where pain-related SA may be even more common than in mixed or male-dominated workplaces (Haukenes & Hammarström, 2023).

7.1.3 SICKNESS ABSENCE TRAJECTORIES AND ASSOCIATED PAIN CHARACTERISTICS, LIFESTYLE AND OCCUPATIONAL FACTORS

This substudy was to the best of our knowledge the first to examine trajectories of long-term SA (spells >10 working days) specifically among young and early midlife municipal employees with pain. Over two fifths of the employees in this age group reported pain (Substudy I), which is associated with later all-cause SA (Substudy II). Substudy III focused specifically on employees who reported pain at baseline, their long-term SA trajectories, and the associated pain characteristics and work-related and lifestyle factors. Identification of such factors could reveal potential targets for measures to prevent long-term SA in this group. Of the employees who reported pain at baseline, three fourths had no long-term SA spells during the 27-month follow up. The baseline prevalence of chronic (47%) and multisite (64%) pain in the study population

was significantly higher than the incidence of long-term SA during the follow up, indicating that many employees work with chronic or multisite pain conditions without having long-term SA.

In addition to the *no LTSA* trajectory, two other long-term SA trajectories were identified; *decreasing* and *increasing* trajectories. Due to the design of this study, the reason for the long-term SA pattern in the *decreasing* trajectory could not be explained. The decrease is likely to be partially related to recovery from illness, but it may also be related to successful rehabilitation, workplace adjustments and the subsequent return to work, or changing workplaces. It is possible that some employees reached the maximum limit of sickness allowance, were granted disability pension, died, or emigrated. These factors could not be accounted for in our analyses, which is an acknowledged limitation. However, disability pension and death are rare in this age group.

The *increasing* trajectory was small, and none of the examined pain characteristics, or the lifestyle or work-related factors showed statistically significant associations with belonging to this trajectory. Descriptive analyses revealed that the *increasing* trajectory included somewhat more semi-professional employees, many of whom in this cohort worked in healthcare and education. The number of mental health-related SA among public sector employees in Finland increased during the follow-up period on a national level, particularly in the healthcare and education sectors (Keva, 2022). To unravel whether the *increasing* trajectory could reflect this pattern, additional sensitivity analyses were conducted. Two items from the RAND36 subscale used at baseline were available for analysis and were found to be associated with both the *decreasing* and *increasing* long-term SA trajectories, the latter for which no other associated factors had been identified (Appendix, Substudy II, Supplementary Table 4). An increase in mental health-related SA could have contributed to the long-term SA pattern in the *increasing* trajectory, but this remains speculative.

Employees with multisite pain, chronic pain, obesity, smoking and those who had a high physical workload, were less likely to belong to the trajectory with no long-term SA during the follow up. The same factors were associated with a higher likelihood of belonging to the *decreasing* trajectory, in which long-term SA was initially high, but gradually declined during follow up. Similar findings have been made previously, but not specifically in this age group, and previous studies have also found other factors to be associated with trajectories with more long-term SA (Hallman et al., 2019; Haukka et al., 2017; Rysstad et al., 2022). Haukka et al. examined long-term SA trajectories during a seven-year follow up of 30–55-year-old Finns with multisite pain and identified two distinct long-term SA trajectories (Haukka et al., 2017). Among the factors associated with the *low* versus *high* trajectory were being a man, doing physically light work, having a healthy weight, and no sleep problems. They found no significant association between alcohol consumption or smoking and trajectory membership in their study. Their study population differed in age and pain characteristics from those in Substudy III, but the

findings of both indicate that obesity and higher physical workload are associated with trajectories with more long-term SA among employees with pain. Similarly, Hallman et al. found that manual work, less LTPA, smoking and multisite pain were among the factors that predicted a trajectory with increasing SA due to musculoskeletal pain during their one-year follow up of Danish employees (Hallman et al., 2019). Thus, multiple lifestyle factors are associated with SA patterns among employees with pain. The variables used in Substudy III were restricted to questions asked in the phone interview and did not capture the role of physical activity and insomnia, which are two modifiable lifestyle factors associated with pain. Obtaining more knowledge on association between these factors and SA patterns among young and early midlife employees with pain could be one aim of further research.

The study design of Substudy III prevented any conclusions being made regarding the causal relationship between pain characteristics, lifestyle and work-related factors and trajectory membership. The findings indicated that smoking and obesity were related to a trajectory with more long-term SA among young and early midlife employees with pain. Obesity is an increasing public health issue among both children and adults in Finland and globally (World Health Organization Regional Office for Europe, 2022). The published findings of a report issued by the Finnish Institute of Occupational Health indicate that the self-assessed work ability among Finnish employees below the age of 30 has declined since 2014, concurrently with a steepening increase in the prevalence of obesity (Laitinen et al., 2024). The increase in obesity, and its association with a pattern of more long-term SA suggests that tackling this issue could be a means to prevent pain and pain-related SA. As smoking is associated with pain and predicts a pattern of more long-term SA among employees with pain, the prevention of smoking may also be a means to prevent pain and pain-related long-term SA.

Doing manual work and perceiving a high physical workload was associated with a higher likelihood of belonging to a trajectory with more long-term SA than to a trajectory with no long-term SA during follow up. The differences between occupations with regards to pain prevalence and SA are already known, and physical work demands are among the factors suggested to explain socioeconomic inequalities in pain to a significant degree (Pekkala et al., 2017; Saastamoinen et al., 2005, Mehlum et al., 2008). Other findings also suggest that occupation class differences in long-term SA are larger for musculoskeletal diagnoses than other diagnoses, which could be explained by pain being more likely to interfere with the work ability of manual workers, who also could be at a higher risk of pain due to work-related strain (Pekkala et al., 2017). Low-threshold services to prevent and manage pain, particularly among employees in manual and physically heavy work could potentially prevent long-term SA in this group.

Adjusting for pain chronicity and multisite pain explained the association between work-related and lifestyle factors and long-term SA trajectory membership to a small extent only, indicating that overweight and obesity,

smoking, manual and physically strenuous work were associated with long-term SA trajectory membership among employees with pain, irrespective of whether the pain was chronic or acute, single-site, or multisite. Rysstad et al. examined SA trajectories among Norwegian employees on long-term SA due to a musculoskeletal disorder and identified six different trajectories. Multisite pain was associated with an SA trajectory with moderate but persistent long-term SA (Rysstad et al., 2022). Their findings were in line with ours, suggesting that multisite pain is associated with a trajectory with more SA.

No clear association between mental workload and trajectory membership was observed. Only one single item measure for mental workload was analysed, and thus this phenomenon may not have been captured adequately. Sensitivity analyses showed that mental workload was reported more often by professionals, who as a group have generally better health and a lower prevalence of SA. This could also have contributed to the lack of a significant association between mental workload and SA in this study population.

7.2 METHODOLOGICAL CONSIDERATIONS

This study was performed using cross-sectional questionnaire data and longitudinal register data on SA. The findings contributed updated knowledge on the burden of pain among young and early midlife municipal employees in Finland, the association with SA, trajectories of long-term SA among employees experiencing pain, and the factors associated with these. This section addresses the limitations and strengths of this dissertation study, first those associated with the data and methods used, and then those related to the generalizability and comparability of the results.

7.2.1 DATA AND METHODS

The young and midlife employees in the target population represented a broad range of occupations in the City of Helsinki, where education and social-healthcare constitute the largest sectors (City of Helsinki, 2023). The study population was large, although the response rate was relatively low (51.5 per cent). Declining survey response rates are an acknowledged problem in public health research. However, a non-response analysis showed that the cohort was largely representative of the study population (Lallukka et al., 2020). Three fourths were women, and this proportion is representative of the gender distribution among Finnish public sector employees. Men and manual workers were overrepresented among the non-respondents. Phone interview responses were used in Substudy III to enable a more representative sample and include more men and manual workers. However, as manually working non-respondents are likely to experience higher morbidity and physical workload, our results concerning socioeconomic differences in pain are likely to be conservative.

All three substudies were observational, either based on solely cross-sectional questionnaire data, or combined with longitudinal register data on SA. Although significant associations were observed, the study design meant that causal inferences could not be made.

To account for multilingualism among the employees, the questionnaires were designed so that the answers could be given in Finnish, Swedish, English, or Russian (City of Helsinki, 2023). All the employees were informed that the collected data would be handled confidentially. However, the employees may have been less eager to report sensitive information such as high alcohol consumption, as the questionnaire was sent to their office email and filled in during working hours. In addition, data obtained by self-reporting can be affected by recall bias. This may particularly concern the item for childhood financial difficulties, as such difficulties may have been only occasional or may have gone unnoticed by the child.

Both pain and mental symptoms are subjective, and thus, only measurable by self-report. The study covered a non-clinical population of employees and focused on pain parameters that can be obtained without a clinical assessment, such as self-reported pain, pain duration, number of pain sites, and chronic pain-related disability. The questionnaire was designed so that pain could be reported as either acute or chronic. However, as acute and chronic pain conditions may coexist, this may be a limitation. In Substudy I, mental health was assessed using the GHQ-12 questionnaire, which is a validated instrument, and in Substudy II, the RAND-36 emotional well-being subscale, which is part of a well-established instrument for measuring health-related quality of life (Hays & Morales, 2001).

Multiple SEP indicators were studied, including indicators of socioeconomic factors in childhood. It is important to consider different indicators simultaneously in order to capture the numerous dimensions of SEP. Education level, for example, tends to remain relatively stable throughout adulthood, whereas income level may change over shorter periods of time. In addition to the GHQ-12 questionnaire, other validated measures were used, such as the Jenkins Sleep Questionnaire to assess symptoms of insomnia and the Chronic Pain Grade to assess the degree of disability due to chronic pain (Jenkins et al., 1988; Korff et al., 1992). Physical activity was not assessed by validated measures, but self-reported activity was calculated as MET-hours per week, which is established practice, and the same classification of activity levels has been used previously (Salmela et al., 2021).

SA data was register based and obtained from two different sources, the personnel register of the City of Helsinki and Kela. Register-based SA data is complete, in contrast to self-reported SA, which can be distorted by recall bias. SA data from the City of Helsinki was restricted to the period of actual employment, but termination of employment during the study period was accounted for in the analyses. Data from Kela was independent of the employer during the study period. Death, disability pension and emigration could not be accounted for as no data on these were available. This is an

acknowledged limitation; however, death and disability pension are relatively rare in this age group. Long-term SA that had been medically certified was analysed separately. However, the total SA burden was also considered, and included shorter spells, which also contribute to productivity loss, indicate poorer health, and are associated with health service utilization and long-term SA (Harkko et al., 2021). As the long-term SA follow-up in Substudy III spanned the same time period for all participants, the time from when the questionnaire was returned to the beginning of the SA follow up differed by approximately two months between the participants. This difference is relatively minor in relation to the total 27-month follow-up.

7.2.2 COMPARABILITY AND GENERALISABILITY

The heterogeneity of the pain and SA measures used previously has been addressed above. This study used similar measures to those of previous studies of Finnish employees aged over 40, and its findings, based on comparable measures of employees aged under 40 from the beginning of working life to early midlife, extends previous knowledge on this subject (Saastamoinen et al., 2005, 2016). An inclusion criterion for Substudy III was pain at baseline, and thus the pain qualifying individuals for inclusion in this substudy ranged from temporary minor aches to longstanding disabling pain. To account for this, we adjusted for chronic pain and multisite pain in the analyses.

Register linkage was permitted by 83 per cent of the women and 80 per cent of the men who responded to the survey. Men were more often manual workers than women, and more likely to report more disabling chronic pain than other occupational groups. This may have contributed to an underrepresentation of those with more disabling pain in Substudies II and III.

Respondents could participate by filling in a web-based or mailed questionnaire, and employees who did not respond to these were contacted for a phone interview. The phone interview was restricted to a smaller set of questions. As many of these items were central for Substudy I and II, the phone respondents were excluded from these two studies. Sensitivity analyses in Substudy II showed that the associations between pain and SA were stronger when the phone respondents were also included, and thus there is a risk that the strength of the associations obtained in the main analyses were underestimated. Including phone respondents, however, made it possible to obtain a more representative sample as it incorporated men and manual workers. Phone respondents were included in Substudy III, but this restricted the analyses to the selection of the variables included in the phone interview. Non-respondents were more often manual workers, who in Substudy reported more pain and pain-related disability (Lallukka et al., 2020). This could also have contributed to an underestimation of the actual burden of pain in the target population of the study.

As shown in a population-based survey in England, the prevalence of chronic pain varied according to employment status, and the respondents who were employed were less likely to experience chronic pain than on average (Public Health England, 2017). The current study focused on young and early midlife individuals who were employed and thus belonged to a selected group of individuals with better general health than the general population. People in a more disadvantaged position outside the labour market or on short-term working contracts were not included, and thus the 'healthy worker effect' needs to be considered when interpreting the findings (Wilcosky T. & Wing S., 1987). It is also worth noting that the study was conducted in the Uusimaa region, where morbidity and SA rates are lower than the Finnish national average (Blomgren et al., 2019; Parikka et al., 2022). The included employees were employees of one single employer, the City of Helsinki, and private sector employees were thus not included. This should be considered when interpreting the generalizability of the results on a Finnish level.

The propensity to take SA may be influenced by sickness benefit policies (Aaviksoo & Kiivet, 2016). Most previous studies using register-based SA data have been conducted in the Nordic countries. Although sickness benefit policies in the Nordic countries share similarities, each country has its own regulations and payments of SA benefits and they may be registered differently (Thorsen et al., 2015). This may restrict the generalizability of the results to other countries.

8 CONCLUSIONS AND IMPLICATIONS FOR PRACTICE AND POLICY

The findings of this study show that pain is a common complaint among young and early midlife employees in the Finnish municipal sector. This dissertation reveals that younger employees are also affected by pain-related disability, highlighting a need for further research in this area and increased knowledge on how pain and pain-related work disability in early careers can best be prevented.

Socioeconomic circumstances are associated with pain among young and early midlife employees, as they also are among older employees (Saastamoinen et al., 2005). Socioeconomic disparities in pain can be partly attributed to the physical demands of certain jobs, and employees with a lower education level and those engaged in manual work are more likely to experience pain, which may stem from a higher prevalence of underlying diseases or pain that is closely related to their occupation (Mehlum et al., 2008). The findings suggest that socioeconomic factors are associated with pain and chronic pain-related disability across multiple indicators, not only occupation. This emphasizes the importance of workplace interventions to prevent work-related pain conditions, particularly for employees in manual and physically heavy jobs, and comprehensive public health strategies to address broader socioeconomic inequalities in pain, while not neglecting the most disadvantaged people outside the labour market

Socioeconomic circumstances and health are known to be intergenerationally patterned. Health inequalities related to SEP emerge early in life and persist throughout the lifespan (Wadsworth, 1997). The findings of the current study suggest that the socioeconomic circumstances of childhood are associated with pain among young and early midlife employees. However, the association between childhood socioeconomic conditions and chronic pain and disability due to chronic pain in later life was only partly accounted for by lifestyle factors. Adulthood SEP and social mobility may contribute to this association, but this study design did not reveal their role. Individuals engaged in manual work as adults are more susceptible not only to chronic pain, but to disruption caused by chronic pain in their work and other life areas. Addressing and reducing socioeconomic inequalities in pain and general health from an early age, by targeting early modifiable risk factors, could potentially reduce inequalities in pain and disability due to pain, particularly among the employees who are most susceptible to the impact of pain on their job performance.

This dissertation study shows that pain is linked to higher rates of SA not only among older employees (Saastamoinen et al., 2009), but among young and early midlife employees. Chronic and multisite pain is associated

with future long-term SA. Employees with chronic multisite pain have more long-term SA, attributable not only to musculoskeletal disorders but also to psychiatric and other diagnoses. Mental health conditions are a predominant cause of long-term SA among young and early midlife employees (Blomgren & Perhoniemi, 2022). Pain is commonly observed alongside mood and anxiety disorders, and young and early midlife employees who experience concurrent chronic or multisite pain and poorer mental health have more long-term SA days than those who experience only one or other of these symptoms. Early identification of employees with concurrent mental health and pain complaints, for example, by OHS, could enable the provision of support to employees at an elevated risk of long-term SA.

Women report more pain than men, have more SA, and constitute the majority of municipal sector employees. Women with multisite pain are at a higher risk of future SA than men. This supports the existing evidence that multisite pain is a risk factor of subsequent SA and highlights gender disparities related to pain and work-related outcomes. Differences in physical working conditions may contribute to socioeconomic differences in SA, particularly among women (Löve et al., 2013). Occupations in the municipal sector that are predominantly female and involve physically demanding work, such as those in healthcare, could benefit from enhanced attention to and improvement of physical working conditions to reduce pain-induced SA.

Although pain is common among young and early midlife employees, merely a quarter of those reporting pain have long-term SA over a subsequent period exceeding two years. Employees engaged in manual and physically heavy work, as well as employees with obesity or smoking habits, were more likely to have a pattern of more long-term SA. The management and prevention of obesity and promoting smoking cessation at the population level, particularly among young and midlife employees already experiencing pain, could serve as strategies to reduce both pain and SA. Moreover, supporting employees who work despite pain, particularly in physically demanding occupations, through workplace modifications and by promoting an inclusive approach towards employees with disabilities in the labour market, may further contribute to reducing long-term SA within this age group.

In summary, pain is often a part of working life, and it is important to help younger employees manage pain to prevent long-term SA, which could ultimately lead to a premature exit from the labour market. Efforts should be aimed to prevent pain among young and early midlife employees at large and to reduce avoidable socioeconomic inequalities in pain. Enhancing mental well-being, encouraging smoking cessation, managing weight, and ensuring safe working conditions should be central to interventions designed to tackle the impact of pain-induced disability among young and early midlife employees who are expected to remain occupationally active for many more decades.

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