The influence of work environment and individual factors on the risk of long-term sickness absence. An epidemiological, registry-based 5-year follow-up study

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Contents

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In 2004, I got in contact with dr.med. Knut Skyberg and professor Petter Kristensen at the National Institute of Occupational Health, Oslo, and professor Bjørgulf Claussen at the University of Oslo. My special thanks go to them for initiating these research projects. In 2004, we applied for our study data and registry linkage, and a year later, at the end of 2005, we received our data. This early project was funded by NHO, and in 2006 we published a report on sector-specific sickness absence in Norway in an inclusive working life (IW)-perspective. In 2007, we received funding from HR for a three-year PhD, and we also received further funding from NHO. In 2008 we received our data and completed a NHO-commissioned Norwegian report on work-related sickness absence in various industry sectors. In 2009 we began work on the present project, funded by HR and developed into a PhD dissertation.

This experience has been a great learning process, and many have helped me along the way. First, a special thank you to my primary supervisor, Knut Skyberg, for having given me independence, yet always being available for important feedback and good advice. To my co-supervisors, Bjørgulf Claussen and Petter Kristensen, for sharing their valuable expertise in epidemiology and for their contributions to statistical challenges. I also thank my co-author, Hans Magne Gravseth, for his contributions to statistical strategies. A special thank to co-author Ingrid Sivesind Mehlum for constructive critical comments and valuable suggestions. I also thank co-author Stein Knardahl for sharing his expertise in the field of musculoskeletal disorders. I am also special grateful to Helge Kjuus, former head of the Department of Occupational Medicine and Epidemiology, for his kind leadership and for providing extra funding for the completion of this thesis.

I wish to thank all my colleagues at the Department of Occupational Medicine and Epidemiology for their consideration and for being good colleagues.

A warm thank to my family and friends; for always providing support and encouragement. Last, but not least, to my dearest Tom and Thomas, for being my inspiration and for their love.

Oslo, January 2013

English summary

The present study was based on self-reported data on health and work-related topics from The Oslo Health Study (HUBRO), linked to several Norwegian registries based on the unique personal identification number. The study population was 10,995 respondents resident in Oslo, Norway, during 2001-2005.

The overall aim of this thesis, was to identify individual and work-related predictors for long-term (> 8 weeks) sickness absence. In Norway, reducing sickness absence and disability is an important political objective. Since October 2001, these efforts have been regulated through the Inclusive working life (IW) program, a Norwegian national intervention program implemented by authorities and major labour market partners. Musculoskeletal disorders and mental health problems are two of the largest diagnostic groups in sickness absence. On this background, three papers have been worked out:

In the first paper, we examined risk factors for long-term (> 8 weeks) sickness absence with psychiatric diagnoses (LSP), focusing on the influence of self-reported health, education and the psychosocial work environment. We found that lack of support from superior and self-reported poor general health seemed to have an independent and moderate adverse effect on LSP. Mental distress had a strong independent effect on LSP, somewhat stronger in men than in women. There was a strong education gradient for women, while in men, there were no statistically significant effects from education on LSP. Path and linear regression analyses indicated that the effect of support from superior on LSP was mediated through self-reported mental distress.

In the second paper, we studied risk factors for long-term (> 8 weeks) sickness absence due to musculoskeletal disorders (LSM), focusing on the influence of the psychosocial and physical work environment, and a special aim was to reveal any gender differences in the associations. We found that men and women aged 40 and 45 had an LSM risk approximately 50% greater than that of subjects aged 30. There was a strong education gradient for both genders. Low job control had a strong effect, especially in men, whereas the effect of low job security was modest. Having shift/night work or rotating hours had a strong effect on the LSM risk, particularly in men. The associations with the job exposure variables were

generally stronger for men; still, the LSM risk was considerably higher for women because of the high risk in women without the studied job exposures. Adding the interaction term (having both psychosocial end physical exposure) to the analysis did not significantly improve the model, and this was the case for both genders.

The aim of the research in paper III was to examine the effect of the IW program by gender on long-term (>8 weeks) sickness absence (LSA), and further, to identify physical work demands and employment-sector-specific patterns on the sickness absence risk. We found that women had a higher risk than men of experiencing an LSA, but the gender-specific differences by IW groups were generally small. In a multivariate model, statistically significant risk factors for LSA were low education (stronger in men), shift work/night work or rotating hours (strongest in men in the non-IW group), and heavy physical work or work involving walking and lifting (men only and stronger in the non-IW group). Among men who engaged in shift work, the LSA risk was significantly lower in the IW group. However, this study could not demonstrate a significantly lower risk of LSA in companies signing the IW-agreement.

This thesis emphasises the importance of the interplay between individual and occupational factors to achieve a deeper understanding of risk factors for long-term sickness absence. Registry data on sickness absence linked to information on diagnoses and self-reported data from health surveys, including information on both the individual and work-related level, as we have collected in this study, may contribute to increased understanding of these relationships. A broad approach that focuses on individuals as well as work-related factors is necessary for preventing sickness absence and disability pensioning and reducing the still large social in equalities in health.

Norsk sammendrag

Studien ble basert på selvrapporterte data om helse og arbeidsrelaterte faktorer fra Helseundersøkelsen i Oslo (HUBRO), koblet med personnummer til flere norske registre. Studiepopulasjonen var 10 995 respondenter som deltok i Helseundersøkelsen i Oslo i perioden 2001-2005.

Hovedmålet med forskningen som presenteres i denne avhandlingen var å identifisere individuelle og arbeidsrelaterte risikofaktorer for langvarig (> 8 uker) sykefravær. I Norge er tiltak for å redusere sykefravær og uførhet et viktig politisk mål. Siden oktober 2001, er dette arbeidet regulert gjennom Inkluderende arbeidsliv (IA)-programmet, en norsk intervensjon iverksatt av myndighetene og partene i arbeidslivet. Muskel- og skjelettplager og psykiske problemer har lenge vært to av de største diagnosegruppene i sykefravær og de er fortsatt økende. Med denne bakgrunnen er det valgt ut tre artikler som utgjør denne avhandlingen:

I den første artikkelen, undersøkte vi risikofaktorer for langtidssykefravær (> 8 uker) med psykiatriske diagnoser (LSP), med vekt på betydningen av egenrapportert helse, utdanning og det psykososiale arbeidsmiljøet. Vi fant at manglende støtte fra overordnet og selvrapportert dårlig generell helse syntes å ha en selvstendig og moderat negativ effekt på LSP. Egenrapporterte psykiske plager hadde en sterk selvstendig effekt på LSP, noe sterkere hos menn enn hos kvinner. Det var en sterk utdanningsgradient for kvinner, mens for menn var det ingen statistisk signifikante effekter fra utdanning på LSP. Stianalyser viste at effekten av sjefsstøtte på LSP risikoen var mediert gjennom dårlig mental helse.

I den andre artikkelen, studerte vi risikofaktorer for langtidssykefravær (> 8 uker) med muskel- og skjelett diagnoser (LSM), med vekt på betydningen av det psykososiale og fysiske arbeidsmiljøet, og et særlig mål var å avdekke eventuelle kjønnsforskjeller i assosiasjonene. Menn og kvinner i alderen 40 og 45 hadde en LSM risiko omtrent 50% større enn personer i alderen 30 år. Det var en sterk utdanningsgradient for begge kjønn. Lav autonomi i jobben og innflytelse over hvordan arbeidet skal legges opp var sterkt assosiert med LSM, spesielt for menn. Menn med fysisk hardt arbeid eller arbeid som krever mye gåing og løfting hadde

en firedoblet risiko for langtidsfravær, mens for kvinner gav dette en fordoblet risiko. Å ha skift eller nattarbeid hadde en sterk effekt på risikoen for LSM, spesielt hos menn. Assosiasjonene med jobbeksponeringsvariablene var generelt sterkere for menn, likevel; LSM risikoen var betydelig høyere for kvinner på grunn av høy risiko hos kvinner uten de studerte jobbeksponeringene. Vi fant ingen signifikant interaksjonseffekt av psykososiale og fysiske arbeidsmiljøbelastninger, og dette gjaldt for begge kjønn.

Målet med forskningen i artikkel III var å studere effekter av IA-programmet for langtidssykefravær (> 8 uker) (LSA). I tillegg ønsket vi å identifisere betydningen av fysiske arbeidsforhold og eventuelle sektorspesifikke arbeidsmiljøbelastninger for sykefraværsrisikoen. Vi fant at kvinner hadde en høyere risiko for langtidsfravær enn menn, men kjønnsspesifikke forskjeller mellom ikke-IA-ansatte og IA-gruppene var generelt små. I en multivariat modell, var statistisk signifikante risikofaktorer for LSA; lav utdanning (sterkest hos menn), skiftarbeid/ nattarbeid eller roterende timer (sterkest hos menn i ikke-IA-gruppen), og tungt fysisk arbeid eller arbeid som involverer mye gåing og løfting (kun for menn og sterkest i ikke-IA gruppen). Blant menn i skiftarbeid, var LSA risikoen betydelig lavere i IA-gruppen. Resultatene i studien kunne likevel ikke vise signifikant lavere risiko for langtidsfravær for ansatte i IA-bedrifter.

Denne avhandlingen vektlegger betydningen av samspillet mellom individuelle og arbeidsrelaterte faktorer for langtidssykefravær. Å benytte registerdata på sykefravær knyttet til informasjon om diagnoser og selvrapporterte data fra helseundersøkelser, på både individ- og arbeidsnivå, som vi har gjort i denne studien, kan bidra til økt forståelse for disse forholdene. En bred tilnærming som fokuserer på individfaktorer så vel som arbeidsrelaterte faktorer er nødvendig med tanke på forebyggingsarbeid rettet mot sykefravær og uførepensjonering og redusere de fortsatt store sosiale ulikhetene i helse.

List of publications

This thesis is based on the following manuscripts:

Foss L, Gravseth HM, Kristensen P, Claussen B, Mehlum IS, Skyberg K. Risk factors for long-term absence due to psychiatric sickness: a register-based 5-year follow-up from the Oslo Health Study. *J Occup Environ Med* 2010; 52: 698-705.

Foss L, Gravseth HM, Kristensen P, Claussen B, Mehlum IS, Knardahl, S, Skyberg K. The impact of workplace risk factors on long-term musculoskeletal sickness absence: a registry-based 5-year follow-up from the Oslo Health Study. *J Occup Environ Med* 2011; 53: 1478–1482.

Foss L, Gravseth HM, Kristensen P, Claussen B, Mehlum IS, Skyberg K. "Inclusive working life in Norway": a registry-based five-year follow-up study. *Paper submitted.*

Abbreviations and definitions

CI Confidence interval
CRE The Central Register of Establishments and Enterprises
FD-Trygd The Historical Event Database at Statistics Norway
GLM Generalised linear models
HR Hazard ratio
HSCL-10 The 10-item Hopkins Symptom Checklist
HUBRO The Oslo Health Study (In Norwegian: Helseundersøkelsen i Bydeler og Regioner i Oslo)
HWE Healthy worker effect
ICPC The International Classification of Primary Care
ICR Interaction contrast ratio
IRR Incidence rate ratios
IW Inclusive working life
LSA Long-term (>8 weeks) sickness absence
LSM Long-term (>8 weeks) sickness absence with musculoskeletal diagnoses
LSP Long-term (>8 weeks) sickness absence with psychiatric diagnoses
NACE The Statistical Classification of Economic Activities in the European Community
NIPH Norwegian Institute of Public Health
NLWA Norwegian Labour and Welfare Administration
NUDB The National Education Database
RD Risk difference
RERI Relative excess risk due to interaction
RR Rate ratio
SEP Socio-economic position

Sickness absence is used synonymously with sick leave

Socio-economic position is used synonymously with socio-economic status and social position

Psychiatric diagnoses is used synonymously with mental disorders and psychiatric disorders

Introduction

A large and growing population of people on long-term sickness absence is a major health and economic problem in Norway and many other Western countries (1-3). Despite improved public health over the last decades, more Norwegians than ever before are outside the work force and rely on ill health benefits. The number of people outside the labour market represents an important burden and challenge at both the individual and contextual levels: to people who generally wish to work, employers, the health care sector and society as a whole (1-8). In Norway, reducing sickness absence and disability is an important political objective. Several studies have sought to explain the reasons for the high rate of sickness absence and disability, but we are still far from a full understanding of the issue (1;9-11).

Long-term sickness absence and disability pension may be viewed as health-related selection out of working life. Long-term sickness absence and disability pension both increase with age and are more frequent among individuals with a low socio-economic position (SEP) (12-14). A specific concern in this context is that the probability of returning to work markedly decreases when the duration of sickness absence increases. Longer absence periods have been shown to affect future labour market attachment in terms of disability pension (7;9;15-17) and mortality risk (18-21). Being part of the active labour force is an important aspect of life in modern welfare states. Labour market participation contributes to social inclusion and reduces the risk of poverty for the sick-listed person. Understanding the reasons why individuals become long-term sick-listed is an important issue, and there is a need for more studies investigating the determinants of long-term sickness absence (6).

As of December 2012, approximately 700,000 persons in the Norwegian work force receive different kinds of benefits. Statistics show that this number is on the rise, especially among young people (22). Medical diagnoses related to mild or moderate mental health problems and musculoskeletal conditions are the most common diagnostic groups for long-term sickness absence and disability pension in Norway and other European countries (9;23). People with absence due to psychiatric and musculoskeletal disorders often have prolonged

absence (2;24-25). These diagnoses are often complex, characterised more by symptoms and distress than by consistent demonstrable tissue abnormalities (26), and are often based on the patients' own reports of pain and other complaints (27). Selection into the labour market exists, as many of these disorders occur at an early age (28). Many young people with psychiatric diagnoses receive disability pension early (17;29-31), and mental disorders are the most important cause of disability in young Norwegian men (32).

However, the Norwegian population generally has good health and an increasing life expectancy. The increase in long-term sickness absence and disability pension is not due to ill health alone, but could be related to changes in working life and health expectations. The reasons for the high levels of sickness absence have partly been ascribed to medicalization of working life or social issues rather than actual biomedical reasons. There are no reasons to believe that there are significant changes in the incidence of mental disorders in the population in recent decades (29-31). Studies from Norway and other international studies indicate that society's way of dealing with these disorders might have changed as more mental health problems and disorders are treated (33;34). More knowledge aimed at addressing important determinants of sickness absence is needed, especially regarding the impact of work ability among younger persons (35).

Income compensation for those who are on long-term sickness absence is a key feature of modern welfare states. Concerns about the level of sickness absence have been growing among policy makers in Norway and many Western countries, primarily due to the high associated costs to enterprises and society (36;37).

Inclusive working life

Many EU governments have introduced programs aimed at encouraging long-term absentees to return to work. There is still limited documentation concerning the effects of workplace interventions on sickness absence. In Norway, reducing sickness absence and disability is an important political objective. This has initiated several actions, like active sick leave, which was introduced in 1993 to encourage people on sick leave to return to modified work. Since October 2001, these efforts have been regulated through the Inclusive working life (IW) program, a Norwegian national intervention program implemented by the authorities and major labour market partners (38). In 2001, the annual level of sickness absence in Norway corresponded to approximately 2.7 billion Euro, and the total absence rate was 7.4%. The IW-agreement is an instrument aimed at preventing sickness absence, increasing focus on job presence and preventing "expulsion" and increasing recruitment to working life among persons who do not have established employment. The IW program represents a new approach to preventing sickness absence, which includes a closer follow-up of the cases. The solutions are anchored in the viewpoint that the workplace is an important arena for organising efforts aimed at reducing sickness absence. Businesses participating in the IW-agreement commit to work systematically following three operational national goals:

1. To reduce sickness absence by 20% (compared with the annual level in 2001)
2. To increase the actual average retirement age
3. To ensure recruitment of people with impaired functioning capacity and other vulnerable groups into the labour market

The agreement was initially intended to apply through 2005. Later, the agreement was renewed three times, most recently through 2013 (39). As of January 2013, the agreement covers approximately 25% of all Norwegian enterprises and 59% of all employees (In Oslo, 55% of employees). Although many good things can be said about the IW work conducted, it has not resulted in a 20% reduction in sickness absence from the 2001 level. Furthermore, we have seen an increase in disability pensions among young people, particularly for mental

illnesses. On the positive side, the average retirement age has risen by approximately a half year since 2001.

Definitions of sickness absence

In Norway, tax-based social insurance is universal, covering all inhabitants, and population-based studies using social insurance data are therefore possible. In epidemiological studies, the definitions of the population at risk and reference population are of high importance. In sickness absence research, a requirement for inclusion in the study base is that an individual belongs to a sickness absence insurance scheme, which is the case in Nordic welfare regimes and several European countries. The benefit schemes for sickness absence vary between countries, and reliable international comparisons are difficult to achieve (24). Studies also use different definitions of absence and criteria for inclusion and exclusion (40-43). Until 2012, after 8 weeks of sickness absence in Norway, the responsible doctor was obliged to produce an 'eight weeks sickness absence certificate' including medical information and plans for treatment and rehabilitation. Therefore, sickness absence longer than 8 weeks has been considered the starting point for long-term absence in Norway (9;44).

Sickness absence in a multidimensional framework

There has been a strong political, but also public and academic, focus on long-term sickness absence. There is an extensive body of literature on risk factors on sickness absence (45), related to a number of areas of research, which confirms the multidimensional character of sickness absence. This research area has a theoretical perspective integrating many explanatory approaches. The link between *having a disease* and *being incapacitated for work* is not inevitably tight. Sickness absence is an indicator of the functional consequences of disease (46). Employees may take sick leave without actual illness or have illness without taking sick leave. Like most measures of morbidity, sickness absence is influenced by social

and psychological factors as well as illness. Sickness absence is important as a measure of ill health, as a measure of use of health services, as a cause of lost productivity, and as an indicator of an employee's ability to cope with and maintain normal roles at work (47). There are many factors that alone or in combination can result in sickness absence; these factors are found at different structural levels in society and are affected by individual factors, factors within the family, factors in the workplace, national sickness benefit policies, and the economic situation in general and society at large (4;6;48). Illness behaviour is usually mediated by strong subjective interpretations of the meaning of symptoms, and as with any type of human behaviour, many social and psychological factors intervene and determine the type of illness behaviour expressed in the individual (49;50). Longer periods of sickness absence are based on a physician's examination rather than self evaluation, further justifying their adequacy as a health indicator (12;20). The Whitehall II study of British civil servants has shown a strong association between indicators of ill health and sickness absence, particularly for longer spells of absence (12).

Work-related factors and socio-economic position

Work-related factors have been shown to be determinants of sickness absence and disability in several studies (3;5;8;10;51-58). The literature on statistical associations between certain working conditions and sickness absence is extensive. Both physical and psychosocial factors within the workplace are shown to be determinants. A great number of work-related factors have been studied, particularly various types of physical workloads (e.g., heavy physical work (59), repetitive movements, awkward postures, and other mechanical exposures (59-61)), organisational factors (e.g., shift work (62)) and industrial downsizing (63-65). Other studies have investigated individual factors like personality (motivation for work, coping strategies, self-efficacy) (50;66), job stress (67;68), job satisfaction (69), the relationship between short- and long-term sickness absence (64), sex (10;70) and pregnancy (71;72). The influence of psychosocial factors (54;68) like social support (73), marital status (74), psychiatric morbidity (28;75) and socio-economic differences (47;76-80) have also been examined. The life course approach has also been applied to research on functions related to work (81), including

sickness absence (82), although research on sickness absence and disability has primarily focused on contemporary factors like working conditions and various socio-economic measures. The British birth cohorts represent an important exception (83;84). In addition, there is the individualistic model, emphasising individual lifestyle factors like substance use (85) and smoking (86).

Psychosocial work factors have been evaluated using various theoretical models, and many studies have relied on one of two influential job stress models, namely the demand-control model (87) and the effort-reward imbalance model (88). During the past three decades the demand-control model has emerged as the dominant model to explain the relationship between the psychosocial features of work organization and health. A meta-analysis of longitudinal studies between 1994 and 2005 found strong associations between job strain and mental distress (89). Modest results were, however, found linking psychological distress with low social support at work, high psychological job demands, low decision authority and low decision latitude. A comprehensive study of the causes of sickness absence carried out in 2004 found moderate scientific evidence of a causal connection with low job control (45). The inconsistency in findings in studies using the demand-control model may be partly due to differences in the definitions and measuring of demand-control, which often differs from the original structures made by Karasek (90;91), and the theoretical progress of the model has been limited (92). Despite many studies and well-documented statistical relationship between working conditions and absenteeism, the scientific evidence for a causal relationship are still largely limited, especially because of possible selection or confounding (93). The contribution of psychosocial risk factors at work may be more important when there is also exposure to physical work factors. Physical and psychosocial work factors coexist and may potentially interact to increase risk (94-96). These factors may amplify (96) each other, and their influence on sickness absence and work ability can be mediated by individual-level and society-level factors (95).

Lately, there has been increasing recognition of the reciprocal nature of the association between work characteristics and health (91;97). Mental health problems might determine selection into certain occupations with poor work environments, which in turn could increase the risk of sickness absence (91). Social inequalities in health are well documented

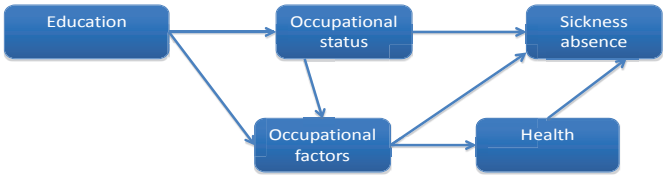
(47;98), and working conditions have been found to influence these differences (56;99). A Danish study reported that physical and psychosocial exposures at work could explain as much as 40-50% of long-term sickness absence differences between the highest and the lowest social classes (78). Earlier studies have reported that people with low levels of education have increased rates of mental health problems (80;100). It is well documented that SEP (e.g., education level) influences health but the causal directions are less studied (47;98). Complicated interactions between health and SEP are described by Stansfeld et al. (83).

Theoretical model

Despite considerable cross-disciplinary efforts over decades, there is need for more knowledge on why people become sick listed, and this may, in part, be due to the different challenges described above. Identifying risk attributable to various factors is important to policy makers in designing preventive measures to reduce sickness absence, and there is need for more studies including variables on both the contextual and individual levels (6;53;101). Knowledge of associations between individual- and workplace-level characteristics of sickness absence could lead to broader preventive approaches and should be pursued in sickness absence research.

In this thesis, we will focus on the associations between SEP (education), psychosocial and physical occupational factors, health and sickness absence. Figure 1 is a simple causal model illustrating possible factors leading to sickness absence. The figure provides an illustrative view of the overall perspective of this thesis. Working conditions may have an impact, whether through negative health effects or through the demands of the work (56). In addition, individual factors like age, gender and lifestyle have an impact. This model is evidently much cruder than the complex social and biological processes that determine sickness absence. Work may also influence sick leave through social mechanisms and personality, which may impact factors like coping behaviour and motivation for work.

Figure 1. Possible causal model of relationships between education, occupational factors and sickness absence.



Aims

General

The overall aim of this thesis was to identify individual and work-related predictors of long-term (> 8 weeks) continuous sickness absence among women and men.

Specific

The specific aims were to:

• identify individual, health- and work-related determinants and the influence of SEP on long-term sickness absence with psychiatric diagnoses (Paper I)

•identify the influence of SEP and work-related risk factors by gender on long-term (>8 weeks) sickness absence with musculoskeletal diagnoses (Paper II)

• examine the effect of the IW program and the associations between employment sector-specific patterns, physical work demands and work schedule on long-term (>8 weeks) sickness absence (Paper III)

Material and methods

Population, data sources

The papers in this thesis are based on data from the Oslo Health Study (HUBRO) (102), a joint collaboration between the city of Oslo, the University of Oslo, and the Norwegian Institute of Public Health (NIPH). The survey took place from May 2000 until September 2001. All individuals in Oslo city born in 1970, 1960, 1955, 1940/41 and 1924/25 (40,888 in total) were invited by letter to attend a health screening. Participation was 45.9% (n=18,770); 42.4% among the men and 49.3% among the women. HUBRO was designed to examine health, socio-economic inequalities and work-related factors. The HUBRO survey included several questionnaires: a main questionnaire presented to all, and supplementary questionnaires given to different age groups. The three youngest cohorts (N= 8,333; aged 30, 40 and 45 years) returned an age-specific supplementary questionnaire, which included questions on work-related factors. In Paper III, our study population was 10,995, as we excluded the age cohort 75 years. We excluded the age groups 75 and 60 years in Papers I and II (8,333 participants) since the questions on psychosocial working conditions were not given to these groups. A list of all topics covered in the questionnaires, explanations of the different questionnaires and the questionnaires in English can be obtained from the HUBRO website (103).

In our study, HUBRO participants were linked to social security information from the Historical Event Database at Statistics Norway (FD-Trygd) (104), an historical event database for national insurance in which the whole population is covered through linking of several official registers based on a unique personal 11-digit identification number. The main topics included in FD-Trygd are demography, social conditions, social security, employment, search for work, state employees, income and wealth. The statistical unit is the person, and information in the database consists of registrations of events in each personal life span. FD-Trygd contains information for the whole population from 1992 and onwards.

The HUBRO participants were further linked to the Central Register of Establishments and Enterprises (CRE) and to the National Education Database (NUDB). CRE is Statistics Norway's registry of all enterprises (juridical units) and establishments in the private and public sector in Norway. The CRE is known as a complete and correct register that forms the basis for a common population for economical and industrial statistics and statistics on individuals. The linkage was made with the enterprise organisation number (ID) linked to the HUBRO participant's personal identification number. We used data from the CRE classified according to the Standard Industrial Classification 2002 (SIC2002) (105), which is a Norwegian adaptation of the statistical classification of economic activities in the European Community (NACE). The use of common standards enables the comparison and analysis of statistical data at the national/international level and over time (105). Serial numbers from the Norwegian Labour and Welfare Administration's (NLWA) IW- registry were also linked to individual data from HUBRO, FD-Trygd and CRE. The IW-registry comprises updated information of all IW-agreements at the company level.

The data on education from NUDB were based on The Norwegian Standard Classification of Education, updated in 2000, referred to as NUS2000 (106). The NUS2000 functions as a classification norm for all educational activities in Norway and for education completed abroad by Norwegian residents. The Norwegian Standard Classification of Education has nine levels and a value for an unspecified level. The level classification is meant to provide the best possible picture of the structure of the Norwegian education system.

The level classification is structured in the following way:

0 No education and pre-school education; younger than school age
1 Primary education, 1st – 7 th class level; compulsory education
2 Lower secondary education, 8th - 10th class level
3 Upper secondary, basic 11th - 12th class level; intermediate education
4 Upper secondary, final year 13th class level +
5 Post-secondary non-tertiary education, 14th class level +
6 First stage of tertiary education, undergraduate level 14th - 17th class level; tertiary education

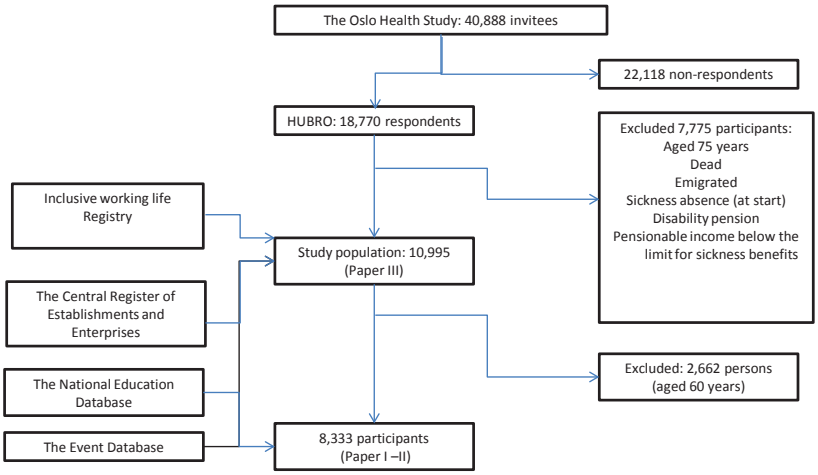
7 First stage of tertiary education, graduate level 18th - 19th class level

8 Second stage of tertiary education (postgraduate education), 20th class level +

9 Unspecified

Diagnostic information was based on the Norwegian short version of the International Classification of Primary Care (ICPC-2) (107). The ICPC has been used by general practitioners since 1992 (108). The ICPC code system is used in the official statistics of sickness absence in Norway. We used the P-chapter (psychiatric disorders) in Paper I and the L-chapter (musculoskeletal disorders) in Paper II. Figure 2 illustrates the data and all registers used for linkage in this thesis.

Figure 2. Illustration of the study data and registry linkage



Outcome variables and outcome measures

Table 1 provides some key information on the study population, outcome variables and outcome measures used in the different papers.

Table 1. Outcome variables and outcome measures

	Paper I	Paper II	Paper III
Outcome (dichotomous)	LSP	LSM	LSA
Population number	8,333	8,333	10,995
Population birth year	1970, 1960, 1955	1970, 1960, 1955	1970, 1960,1955 1940-41
Follow-up	2001-2005	2001-2005	2001-2005
Analyses	Cumulative incidence Cox regression Path analysis	Generalised linear models	Cumulative incidence Cox regression
Covariates			
Age	X	X	X
Education	X	X	X
Work			
Job control	X	X	
Support from superior	X	X	
Job security	X	X	
Combined job exposure		X	
Physical job demands		X	X
Work schedule		X	X
Industry group			X
IW affiliation			X
Health			
General health	X		
Mental distress	X		
Work-related health	X		

Lifestyle			
Smoking	X		
Alcohol	X		
Social affiliation	X		
Good friends	X		
Social activities	X		

Description of variables

Education

The classification of SEP was based on registry information on education level from the NUDB according to the standards of Statistics Norway (106), simplified and collapsed into five ordered education categories and a missing/unspecified category: primary education/lower secondary (1); upper secondary education, basic (2); upper secondary, final year/post-secondary non-tertiary education (3); first stage of tertiary education, undergraduate level (4); first stage of tertiary education, graduate level/postgraduate education (5); and a missing value (6). Missing values were included as separate categories throughout the analyses.

Occupational factors

The psychosocial job exposure variables included in the analyses were as follows: job control, support from superior and job security.

The question on *job control* was *"Can you yourself decide how your work should be organised?"* The four response categories were dichotomised into “Good” or “Poor”.

Support from superior was measured by merging the two following questions: *“If needed, can you get support and help with your work from your immediate superior?“* and *“Are your work achievements appreciated by your immediate superior?”* (Response categories: *Very seldom or*

never (score 1), *Rather seldom* (score 2), *Sometimes* (score 3), *Rather often* (score 4), *Very often or always* (score 5)). The scores from the two questions were added. Thus, the participants were given a total score from 2 to 10, dichotomised into *Poor support* (score 2-5) and *Good support* (score 6-10).

Job security was measured by merging the two following questions: "*Are there rumours concerning changes at your workplace?"* (Response categories*: Very often or always* (score 1)*, Rather often* (score 2)*, Sometimes* (score 3)*, Rather seldom* (score 4)*, Very seldom or never* (score 5)) and *"Are you confident that in 2 years from now you will have a job that you consider as attractive as your present job?"* (Response categories*: Very little or not at all* (score 1)*, Rather little* (score 2)*, Somewhat* (score 3)*, Rather much* (score 4)*, Very much* (score 5))*.* Thus, the participants were given a total score from 2 to 10, dichotomised into *Poor job security* (score 2-5) or *Good job security* (score 6-10)*.*

The physical and organisational job exposure variables were as follows:
The work schedule variable was based on the following question: "*Do you do shift work, night work or have rotating hours of work?"* The response categories were *Yes* or *No.*

Physical job demands were measured by the following question*: " If you have paid work or do unpaid work, how would you describe your work?"* (choose only one) *Mainly sedentary work? Work involving a lot of walking? Work involving a lot of walking and lifting? Heavy physical work?* The two last categories were merged into one category.

To investigate possible interactions between psychosocial and physical job exposure and LSM, we constructed *a combined job exposure variable*. This variable had the following four categories*: No exposure* (no positive answers to any of the questions on job exposure), *Psychosocial exposure only* (a positive answer to any of the questions on psychosocial exposure and no physical exposure), *Physical exposure only* (having an occupation that included significant walking or walking and lifting or heavy physical work and no positive answers to any of the questions on psychosocial exposure), and *Both psychosocial and physical exposure.*

Industrial classification

We made use of data on industry and on the following industry group categorisation based on the Standard Industrial Classification (SIC2002) by Statistics Norway: 1) secondary industry (industry, building/construction, SIC2002 codes 10 – 45), (2) tertiary industry, heavy (retail, hotel/restaurant, transport/storage/communication, SIC2002 codes 50 – 64), (3) office work (service trades/insurance, civil service, SIC2002 codes 65 – 75), (4) the teaching sector (SIC2002 code 80), (5) the health sector (health and social care, social services, SIC2002 codes 85 – 93) and (6) other/unknown (SIC2002 codes 00 – 05, 95 – 99).

Self-reported health

Mental distress was measured by the 10-item Hopkins Symptom Checklist (HSCL-10) (109). The test asks about psychiatric symptoms like depression and anxiety on a four-point scale ranging from 1=*"Not at all"* to 4=*"Extremely"*. The average item score was calculated by dividing the total score on the 10 items, resulting in a continuous scale ranging from 1 to 4. Each item was rated on a scale of 0 (Yes) to 1 (No) during the past week. The scale was used as a categorical variable with a cut-point of 1.85 (109).

Self-reported general health was measured by the question: *"How would you describe your present state of health?"* The three response categories were *Poor, Good,* and *Very Good.*

Work-related health was measured with the question*: "Have you experienced any of the following common health problems during the last month, and are they totally or partially caused by working conditions in your present or previous jobs?"* This was followed by a list of 11 common work-related health problems:

(i) *eye symptoms with itchiness, soreness, redness or watering eyes*
(ii) *nose symptoms with stuffiness, sneezing or running nose*
(iii) *chest tightness, wheezing*
(iv) *heavy breathing when walking up hills or climbing stairs*
(v) *eczema, itching skin, skin rash*

(vi) *impaired hearing*

(vii) *pain in neck or shoulders*

(viii) *pain in elbow, forearm, hand*

(ix) *low back pain*

(x) *extraordinary tiredness or fatigue*

(xi) *sleep disturbance, problems falling asleep*

The response categories were *No, I have not experienced this; Yes, but not caused by work* and *Yes, totally or partially caused by work.* The response categories were dichotomised into *Yes,* for positive answers for symptoms partially or totally caused by work, and *No.*

Lifestyle

Smoking was measured with the question: "*Have you smoked/do you smoke daily?*" The response categories were *Never/Yes, before/ Yes, now.* Alcohol use was measured with the question: *"Have you, during one or more periods in the last 5 years, drunk so much alcohol as to hamper you socially or at work?*" The four response categories were dichotomised into *Yes, socially and/or at work* or *No*.

Social affiliation

We used the two following questions: *Do you feel you have enough good friends?"* (Response categories: *Yes* or *No*) and *"How often do you take part in some kind of club/social activities?"* The four response categories were dichotomised into *1-2 times per month or more* and *Never or a few times per year*.

Musculoskeletal pain

In an earlier version of Paper II (not published), we included a variable on musculoskeletal pain into our analyses. The results from these unpublished analyses are described in the Results section "Supplementary analyses". The measure of *musculoskeletal pain* was based on the question: *"Have you suffered from pain and/or stiffness in muscles and joints in the course of the last 4 weeks?* This was followed by a list of six musculoskeletal areas: *neck/shoulder, arms/hands, upper back, lower back, hips/legs/feet* and *elsewhere.* The

response categories were *Not troubled, Somewhat troubled* and *Very troubled. The response categories Somewhat troubled* and *Very troubled were merged.* The sum of the number of reported pain sites was calculated and then recoded into 7 groups (0,1,2,3,4,5,6 pain sites) (110).

Statistical analyses

The analyses in Papers I and II were restricted to the 30-, 40- and 45-year age groups (8,333 participants) because questions on psychosocial working conditions and work-related health were not given to the 60- and 75-year age groups. In Papers I and II, we collected data on the first spell of LSP (ICPC-2, chapter P) and LSM (ICPC-2, chapter L) for 8,333 participants (4,411 women and 3,922 men) who were considered at risk for sickness absence on January 1st, 2001. In all three papers, those not considered at risk for sickness absence were excluded from the analyses. This group comprised, in categories that were not mutually exclusive, people who had died, emigrated, or received disability pension before the start of the follow-up, persons with pensionable income in 2001 that was below the limit entitling them to sickness allowance and persons on sick leave on January 1, 2001. The follow-up lasted from 2001 until the end of 2005.

In Paper III, the cohort was divided into IW and non-IW groups. An "IW employee" was defined as a person employed in an IW enterprise after the agreement was enacted in 2001. Following this definition, out of a total of 10,995 participants, 4,791 persons (2,733 women and 2,058 men) were IW employees (43.6%). The remaining 2,973 women and 3,231 men were classified as non-IW employees.

For Paper I, Stata/SE 10.1 was used in the analysis. Cox proportional hazards models were used for computing LSP hazard ratios (HR) and the corresponding 95% confidence intervals (CI). All analyses were stratified by gender. Follow-up lasted until the end of 2005. Censoring occurred when persons during the follow-up period died, emigrated or received a disability pension or early retirement pension; this was the case for 212 persons. Sickness absence

with other diagnoses was ignored. We considered the causal pathways leading to LSP, and the coefficients for pathways were computed with the "pathreg" command in Stata (111).

For Paper II, Stata/SE 10.1 was used in the analysis. Proportions of LSM according to age, educational level and the job exposure variables were computed using cross tabulations. All analyses were stratified by gender. GLM (generalised linear models) were used for computing the adjusted LSM risk differences (RD) and the corresponding 95% confidence intervals (CI) for the job exposure variables.

For Paper III, Stata/SE 11.2 was used for the analysis. Cox proportional hazards models were used to compute the LSA hazard ratios (HR) and corresponding 95% confidence intervals (CI). All analyses were stratified by gender. We adjusted for age, education, industrial classification and work-related variables on physical job exposure. We also performed a gender-stratified Cox regression to estimate the relative IW effect. Gender-stratified models were estimated in certain subgroups in which the results indicated heterogeneity. The follow-up period lasted until the end of 2005. Censoring occurred when individuals died, emigrated or received a disability pension or early retirement pension during follow-up. Of the total sample, 776 persons were censored.

Ethical approval

HUBRO was recommended by the Regional Committee for Ethics in Medical Research and by the Data Inspectorate of Norway, The Norwegian Directorate for Health and Social Affairs and The Norwegian Institute of Public Health. Concession has been granted for the linkage of data between HUBRO and Statistics Norway. The study was approved by the Regional Committee for Ethics in Medical Research (no: S-04365) and by the Data Inspectorate of Norway, The Norwegian Directorate for Health and Social Affairs and the National Institute of Public Health (NIPH). Data security and confidentiality are important when managing a data set like ours, which contains sensitive information. We also obtained an exemption from the duty of confidentiality from the Directorate for Health and Social Affairs.

Results

Paper I

Risk Factors for Long-Term Absence Due To Psychiatric Sickness: A Register-Based 5-Year Follow-Up From the Oslo Health Study

The primary aim of this paper was to identify individual, health and work-related determinants and the influence of SEP on long-term (>8 weeks) sickness absence with psychiatric diagnoses (LSP).

During follow-up, 344 (7.8%) women and 153 men (3.9%) experienced at least one LSP. For the total population, the LSP risk was 6.0%. Diagnoses related to depression were very common, accounting for 63% of the diagnoses in both genders. In the fully adjusted model, statistically significant risk factors for LSP were lack of support from superior and self-reported poor general health, which seemed to have an independent and moderate adverse effect on LSP. Mental distress also had a strong independent effect on LSP, somewhat stronger in men than in women. In women, the lowest education categories (levels 1-4) had considerably greater risk than the reference category (graduate tertiary), while in men, there were no statistically significant effects of education on LSP. Alcohol problems for men and present smoking for women were also independently associated with LSP. The effect of social affiliation for women and work-related health problems on LSP risk was modest, as was the effect of job insecurity and low job control.

Path and linear regression analyses indicated that the effect of support from superior was mediated through mental distress. There was less evidence for mediation through the opposite pathways (via support from superior). In conclusion, women were at greater risk of LSP than men. Low education, poor support from superior, and mental distress were found to be determinants of LSP.

Paper II

The Impact of Workplace Risk Factors on Long-term Musculoskeletal Sickness Absence: A Registry-Based 5-Year Follow-Up From the Oslo Health Study

The primary aim of this paper was to identify the influence of SEP and work-related risk factors by gender on long-term (>8 weeks) sickness absence with musculoskeletal diagnoses (LSM).

During the five-year follow-up, 554 (12.6%) of the women and 347 of the men (8.8%) experienced at least one LSM. The LSM risk for the total study population was 10.8%. Diagnoses related to neck and upper extremities were common in both genders, accounting for 34.3% of the diagnoses in women and 28.8% in men. Back-related diagnoses constituted a larger proportion in men (31.7%) than in women (25.8%). Men and women aged 40 and 45 years had an LSM risk approximately 50% greater than subjects aged 30 years. There was a strong education gradient for both genders, and the lowest education category (primary education/lower secondary) had a 4-fold and 8-fold increased risk among women and men, respectively, compared with the highest education category.

Our analyses of the 5-year risks of LSM by age, education and work-related factors across genders revealed that low job control had a strong effect, especially in men, whereas the effect of low job security was modest. Having shift/night work or rotating hours had a strong effect on LSM risk, particularly among men. There were 2-fold and 4-fold increased risks of LSM in women and men, respectively, for persons who performed heavy physical work or work that involved a lot of walking and lifting compared with those engaged in sedentary work. In the adjusted generalised linear models analyses, statistically significant risk factors for LSM were low support from superiors (women only), low job control (men only), having shift/night work or rotating hours (men only), and having heavy physical work or work that involved a lot of walking and lifting, which was strongest among men.

To investigate possible interactions between psychosocial and physical job exposure and LSM, we constructed a combined job exposure variable; however, adding the interaction term to the analysis did not significantly improve the model for either gender. In conclusion, associations with the job exposure variables were generally stronger for men, although LSM risk was considerably greater for women due to the high risk among women without the studied job exposures.

Paper III

"Inclusive Working Life In Norway": A Registry-Based Five-Year Follow-Up Study

The objective of this paper was to examine the effect of the IW program and the associations between employment sector-specific patterns and physical work demands and work schedule by gender on long-term (>8 weeks) sickness absence (LSA).

A total of 3,663 employees experienced at least one LSA during the five-year follow-up period (risk 0.333.) Women were at greater risk than men for experiencing an LSA, but the gender-specific differences by IW groups were generally small. In total, 43.2%/41.6% of women and 22.3%/24.3% of men (IW/non-IW, respectively) experienced at least one LSA. For men, there was a strong, positive relationship between age and LSA risk, whereas for women, the youngest age cohort had the greatest LSA risk. There was a strong education gradient for both genders, but it was more pronounced for men.

Among women in IW companies compared with non-IW companies, a greater proportion worked in the health sector (38.5% vs. 21.4%), had shift or night work (19.3% vs. 9.2%), or had heavy physical work (15.8% vs. 9.1%), while a lower proportion was 60 years of age (19.6% vs. 25.5%). In addition, there were also systematic differences between the IW and non-IW groups in these variables for men. Women exhibited a greater LSA risk than men, but the associations between a high physical workload and shift/night work and LSA risk were stronger for men than for women. IW and non-IW persons differed systematically by demographic characteristics and work environment. Women working in the health sector demonstrated the greatest LSA risk. For men with IW employment, the greatest LSA risk was observed in secondary industry, heavy tertiary industry and the health sector. For men in the non-IW group, the greatest LSA risk was observed in heavy tertiary industry.

In a multivariate model, statistically significant risk factors for LSA were low education (stronger in men), shift work/night work or rotating hours (strongest in men in the non-IW group), and heavy physical work or work involving walking and lifting (men only and stronger

in the non-IW group). Among men engaged in shift work, LSA risk was significantly lower in the IW group. Our results suggest that the IW companies that employ many men in shift work may have implemented some relevant efforts for reducing sickness absence. However, this study could not demonstrate a significantly lower risk of LSA in companies signing the IW-agreement.

Supplementary analyses

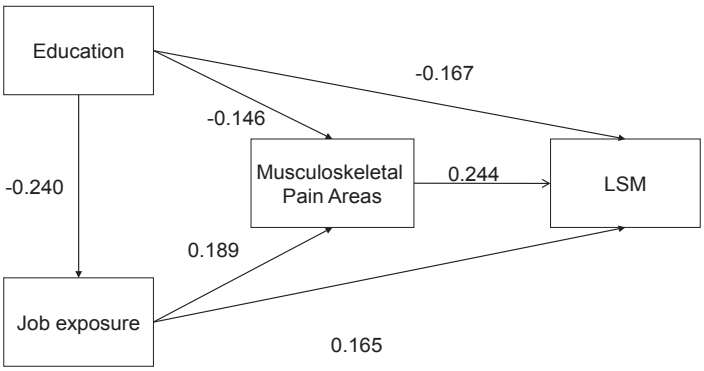
In an earlier version of Paper II, we investigated the possible interactions between psychosocial and physical exposures by comparing the risk difference for those having both psychosocial and physical exposures. We also included HUBRO questions on musculoskeletal pain and considered the causal pathways leading to LSM as illustrated in Figure 3 (unpublished analyses).

We defined interaction as a departure from the additive effect of the combined job exposure variable. We also calculated the interaction contrast ratio (ICR), (previously called the "relative excess risk due to interaction" (RERI), RERI = RR(AB)-RR($\bar{A}$B)-RR(A$\bar{B}$)+1)). Rothman (112) (p. 299) notes that ICR=0 in the absence of an interaction. We calculated the adjusted IRR (incidence rate ratios) using a Poisson regression. The measure of interaction was then computed according to the ICR formula. The confidence intervals were calculated using the method of Hosmer and Lemeshow (113). We found that the risk difference in men for the total effect of both physical and psychosocial exposure was 0.092, while the sum of the physical and psychosocial exposure categories separately was 0.067 (i.e., there was a more-than-additive risk). For women, the corresponding total risk difference was 0.069, and the sum of the single categories was 0.062. The ICR analyses were not significant for either gender (data not shown).

The coefficients for the pathways were computed using the "pathreg" command in Stata. We also computed the degree of mediation through simple multiplication. This analysis was performed with four strata by crossing male or female and with and without mental distress (as mental health might act as an effect modifier in the relationship between job exposure, musculoskeletal pain and LSM). The results indicated that the pathways shown in Figure 3 fit the data better than the reverse pathways. For example, there was no strong evidence that the effect of increasing numbers of musculoskeletal pain sites was mediated through job exposure. The path analysis also showed that the effect of job exposure on the LSM risk was mediated through musculoskeletal pain to a higher degree in men than in women, especially in men with mental distress.

There was a strong association between musculoskeletal pain and LSM, and there was an equally strong but inverse association between educational level and adverse job exposure. Multiplying the individual coefficients of job exposure by the musculoskeletal pain sites and comparing them with the direct pathway coefficients gives an estimate of the degree of mediation through musculoskeletal pain. In the stratum of men with mental distress, 21.8% of the effect of job exposure on LSM was mediated through musculoskeletal pain: (0.189*0.244)/(0.165+0.189*0.244)=0.218 or 21.8%, vs. 9.1% in men without mental distress. For women with and without mental distress, the corresponding results were 4.7% and 7.0%, respectively.

Figure 3. A causal diagram showing possible determinants and pathways leading to long-term (>8 weeks) sickness absence due to musculoskeletal diagnoses (LSM). N=238 men with mental distress



Discussion

In this longitudinal, prospective cohort study, with both self-reported and registry-based data, we have identified individual and work-related predictors for long-term (> 8 weeks) sickness absence, considering psychiatric and musculoskeletal disorders.
In several ways, Paper III differs from Papers I and II; whereas Papers I and II primarily investigated the influence of SEP, individual-level variables and work characteristics on the diagnosis-specific LSP and LSM risk, the primary objective in Paper III was to examine the effect of working in an enterprise participating in the IW-intervention program on LSA risk. In Paper III, sickness absence risk was analysed regardless of diagnoses and data on self-reported health, and psychosocial work factors were not included in this paper. The three papers have in common that they identified significant associations between age- and SEP-adjusted work-related factors on long-term sickness absence risk.

Validity concerns

Selection bias

Bias is an unavoidable problem in epidemiological research. Selection bias due to non-response is regarded as a problem in health surveys. The low attendance rate (46%) in HUBRO may have led to self-selection of healthy subjects into the study. Among healthy worker-related biases, the inconsistency of health status between study cohorts and the general population (confounding bias) and the study of active workers (selection bias) is of high importance (114). The healthy worker effect (HWE) bias is an example of a selection bias that may lead to underestimation of the mortality/morbidity related to occupational exposures. Participation in HUBRO was higher among females than among males and increased with age, which is similar to other population surveys (115-118). Søgaard et al. described the HUBRO Study methods and sample in detail (119). The low attendance in the HUBRO Study has been a matter of concern, and the possibility of selection bias has been

thoroughly examined by linking socio-demographic data from Statistics Norway to the non-attendees (119), based on information from all 40,888 invitees to the Oslo Health Study. Søgaard et al. found that the response rate was positively associated with age, educational attainment, total income, female gender, being married and not receiving disability benefits. The effect of low attendance in the main survey according to socio-demographic variables had little impact on the prevalence estimates of examined health-related variables (self-rated health, mental health and smoking). Unhealthy individuals attended to a lesser degree than healthy individuals, but inequalities in health by different socio-demographic variables appeared unbiased on a ratio scale (119). As poor health is often associated with poor work environment (114), this finding may imply a lower response rate among subjects with poor work environments.

Recall bias arises partly because those who have developed the disease are more aware of possible causes than those who have not developed a disease, and therefore may report that they have been exposed to a particular exposure more frequently. The longitudinal cohort design reduces uncertainty about whether the possible cause precedes the effect in time, which is a significant problem in case-control studies (114).

Information bias

Self-report is widely used in epidemiology, but it raises problems related to the accuracy of the data collected. Subjects might tend to report what they believe the researcher expects to see and might also report what reflects positively on their own abilities, knowledge or opinions, which can result in under- or over-estimates. The HUBRO study compared self-reporting to physician assessment for 217 people suffering from neck/shoulder or arm pain (115) and found that self-reporting appeared to give a reasonably good measure of the work-related proportion of health problems. It was found that self-reported pain was regarded to be work-related slightly more often than the physicians: 80% versus 65% for neck/shoulder pain and 78% versus 72% for arm pain (115). Reliance on self-report for the measurement of both dependent and independent variables raises concern about the validity of causal conclusions. Errors in the association between exposure and outcome due to measurement errors can lead to false associations. A key strength in our study is the use of two data sources on exposure and outcome, HUBRO and FD-Trygd, as this linkage of self-reports to registry data reduces the problem of common method variance and self-report bias. Our prospective registry linkage design has advantages compared with another much used design that is only based on self-reports and self-reported outcome measures (120). Studies of psychosocial work characteristics and health, suggesting a causal role of working conditions on health, have been criticised on methodological grounds for an undue reliance on self-reported outcome measures and for not addressing the possibility of information bias (114). The major precaution that should be taken to eliminate bias from dependent error is to break the bond between information on exposure and outcome by gathering data from two separate sources (121), as we have done in this study. The basic source of dependent error is usually normal variation in certain personality traits in self-reports or inadequate measurement tools. Registry-based rates of physician-certified sickness absence can serve as a better measure of health status than self-reports, which are often biased (12;48;122). Data on educational level were also derived from the public registry.

Emotional states are important in explaining the relationship between work environment, affective characteristics, and work attitudes and behaviour. Lack of control over one's own

life has been suggested as a crucial factor in explaining the high level of mental disorders, "control" being measured as a "sense of mastery", "self-efficacy", lack of control over work, coping behaviour or other related measures. An evident weakness with our design is the lack of important variables e.g. related to coping strategies and self-efficacy, as sickness absence should also be regarded as a choice that is based on factors that encourage or discourage work (i.e., it is a form of coping behaviour) (123).

Confounding

Confounding is an issue of concern in epidemiological studies. A confounder is a variable that causes a spurious association between the exposure and the disease, a third variable that is a common antecedent to both. A confounder is a true risk factor for the disease (although it need not be a cause of disease), but it differs from a mediator by not being part of the causal pathway between the exposure and the disease. In addition to spurious associations, confounding might cause over- or underestimation of the effect. Limitations due to potential information bias or confounding in our study are plausible. These limitations include possible errors in model specifications, lack of quality in the study variables and unmeasured variables of potential importance.

An essential goal in epidemiology is to attempt to falsify or to support hypotheses about the relationship between one or more possible causal factors and the disease (outcome). To determine causality, it is not enough to simply discover statistical correlation. In epidemiology, the control for confounding and addressing problems with selection is important. The relationship between SEP, the work environment, health and sickness absence are complex and difficult to quantify. Thinking about the ways in which variables may be related illuminates bias and confounding. Not every factor that is associated with both the exposure and the outcome is a confounding variable. Such a factor could also be a mediating variable**.** A mediator is also associated with both the independent and dependent variables, but is part of the causal chain between the independent and dependent variables.

The results are model-dependent and therefore sensitive to the factors that are included in the analysis. There could be several other mediators, confounders and effect modifiers than those outlined in this study. As mentioned earlier, some mediators, including personality traits, may exist on the pathway from the work environment to sickness absence. Personal mastering strategies or self efficacy could be affected by SEP and affect the answers for job satisfaction (83;91). One study has investigated mastering in relation to disability pension with HUBRO data (124). The authors found that the risk of receiving disability pension was more than five times greater for those with primary school education than for those with university education, and those with poor mastering had an age-, gender- and health-adjusted OR of 2.4 compared with the highest level of mastering (124).

Confounding could be *prevented* through the choice of design of study, or *controlled for* in the data analysis. The two main methods for controlling for confounding in the analysis are stratification, which may reveal the problem of confounding and provide a better measure of the association (112; page 258-282), and the use of multivariate regression models (112; page 381-417). Multivariable regression analyses were widely used in our study, making it possible to control for several variables simultaneously. Nevertheless, there still is a possibility of unmeasured confounding in our study due to the lack of some important variables mentioned previously. The results in our study also depend to a great extent on whether the proposed model is correct. It is possible that confounding factors missing in our gender stratified models might be of significance if included in our analysis of sickness absence risk. Different factors concerning family obligations between the genders may also be explanatory factors for sickness absence. Unmeasured risk factors, possibly related to women's care work, may help to explain the gender differences. However, we unfortunately do not have information on the participants' number of children or their domestic workload.

SEP measures like education, occupational class and income are well-known determinants of health. We used education as the only measure of SEP, though we do have data on income and occupation; this is because income and occupation were self-reported and had a relatively high proportion of missing values, whereas education was registry-based. Studies have also found educational level and occupational class to be better measures of socio-economic position than income (125;126). Another advantage of using education as a

measure of SEP is that it usually does not vary over the adult lifespan (125;127) and thus reflects more stable aspects of SEP. In an earlier version of Papers II and III, we included occupation in the models; however, we concluded that this was over-adjusting for SEP, and we believe occupational exposures are covered using the various job exposure variables. We also believe that the inclusion of income would lead to over-adjustment, and income is not the best measure to elucidate gender differences, as women could have a low income but still be wealthy if financially supported by their spouse.

The labour market in Norway is highly gender segregated. Studies have shown that occupational groups dominated by one gender have greater levels of absence (128;129). Work tasks and working conditions may differ substantially between the genders or between female- and male-dominated occupations. In all papers, we stratified by gender. It should also be mentioned that control for confounding is *not* the only reason for stratifying by gender, which also serves to check for heterogeneity; does the exposure-disease relationship differ between genders? Gender should rarely be treated as a confounder; instead, it is often recommended to perform analyses for the two genders separately. We stratified by gender because we believe this is a better practice for evaluating gender differences, rather than, for example, treating gender as a confounder. Even interaction terms could turn out to be non-statistically significant when gender segregation is great, as it often is in the labour market (130).

In this thesis, we used Cox regression and generalised linear models, but these methods can hardly infer causality or indicate the relationship between the different variables (the direct and indirect effects). The results of these analyses are highly dependent on the choice of model; i.e., the kind of adjustments performed. An understanding of the causal structure is essential for assessing these relationships correctly. An important challenge in this follow-up study is that information about working conditions and health were registered at the same time, and this makes it difficult to determine their position in the causal chain (91). There has been an increasing recognition of the reciprocal nature of the association between work characteristics and mental health, as mental health may influence working conditions and perceptions of the workplace, while working conditions may affect mental health (83;91;97). Mental distress might act as a mediator or a confounder in the relationship between working

conditions and sickness absence. Conversely, poor mental health might lead to selection into jobs with poor work environments ("unhealthy worker effect"). Being mentally distressed is also associated with people having negative associations with their social environment (e.g., in workplace characteristics) (83), which may confound the relationship between working conditions and sickness absence. More than one analytic approach should be used (131), and this can be facilitated through the use of causal diagrams and structural equation models (directed acyclic graphs (DAGs)). In Paper I, we disentangle these relevant interactions with path analyses and suggests that it is more likely that poor work environment affects mental health rather than poor mental health leading to selection into jobs with poor work environments; an important mechanism for this relationship, particularly in certain psychiatric outcomes (83;97). It must be stressed that whether the relationship between occupational factors and LSP is causal is an extremely complex topic, and incomplete adjustments for these influences may explain some of the variability in the association estimates between work characteristics and common mental disorders (83). Path analysis address the direct, indirect and total effect constructs. DAGs are a tool to set up models of how variables are linked, both in terms of time and causally; i.e., what affects what? The time axis is implicit in the charts, as time goes from left to right. This also means that no arrows can go to the left; i.e., graphs are acyclic. One composes models from hypothesis based on what may be biological, psychological or social scientifically plausible (125;132). Although there is a vast methodological literature on the estimation of the effects of mediators, one may easily ignore the technical challenges raised by measurement errors in the proposed mediators and by potential hidden confounding of mediators and outcome. Propositions about mediation are usually not definitive but are a step closer to deeper understanding (133). Recently, a number of new methodological tools have been developed in this field of causal inferences, and they can be viewed as further developments of structural equation models (134;135). A large portion of our results require interpretation and are dependent on the choice of model. There is undoubtedly unmeasured confounding in our study, which could produce biased results in either direction. Further research in this field should especially focus on minimising this unknown effect.

Measuring sickness absence

In the sickness absence research field, the population at risk can be identified at three levels: the general population, the sickness insured population, and the sickness absent population (136). Cases in sickness absence studies can be quantified in terms of spell-, person-, or time-based measurements, and the choice of measurement should be determined by the purpose of the study. Methods for calculating sickness absence vary: frequency of sick leave, length of absence, cumulative incidence, incidence rate, cumulative incidence and duration of sick leave (136). In all papers, we measured sickness absence as the cumulative incidence during the 5-year study period; i.e., the proportion of persons having at least one spell (with the relevant diagnosis and minimum length) during the given period.

Missing values

Missing data is a problem in epidemiology, and our choice was to include missing values in the analysis as separate categories. Missing values of many variables seemed to have a strong effect; therefore, the modelling of missing data in this study is quite suggestive of the loss to risk estimates.

Comparison with other studies

Job insecurity had a modest effect on the LSP and LSM risk. However, because people change jobs, particularly individuals who are not satisfied with their work, the study participants' work environment might have changed during the 5 years of follow-up and thus diluted the effects. Finding new employment can result in higher levels of job control for both healthy and unhealthy workers. Job insecurity can also be interpreted as "sickness presenteeism" (i.e., people attend work even if they are ill in times of lower job security) (137).

A female excess in sickness absence is observed in countries with different social insurance systems and different levels of sickness absence (138). In Paper II, we consider the extent to which physical demands and job conditions like autonomy, insecurity and supervisor support help explain long-term sickness absence with musculoskeletal disorders. This paper also considers the extent to which these different exposures might explain the long-established higher prevalence of vulnerability to musculoskeletal disorders among women. Our results in Paper II challenge the consistent finding of gender vulnerabilities, and we suggest that a reason for this could be related to our use of registry data as the outcome measure compared with self-reported outcomes. Most previous studies have investigated the occupational associations of pain in single-anatomical areas (139-141).

Unfortunately, the questions in HUBRO do not allow analyses according to the traditional axes “demand-control” and “effort-reward imbalance” (87;88). However, an important shortcoming of these models is lack of measures on self-efficacy in predicting work engagement. Most research on job stress models has also been restricted to a given and limited set of variables that may not be relevant for all job positions (92). In paper I, we found that lack of support from superior seemed to have an independent effect on LSP for both genders, in line with other findings on psychiatric sickness (73). In our study on LSM, low support from superior was only statistically significant for women. A review (142) has investigated the relationship between inequalities experienced at work with respect to social support and work-related musculoskeletal ill health. The studies varied greatly in the breadth of definitions of social support used, and many measures were employed for the collection of data. There was strong evidence for an association between poor social support and an increased risk of musculoskeletal morbidity; however, there was limited evidence that poor social support was associated with musculoskeletal sickness absence. A small number of studies have reported the effects of good social support and its importance in protecting against musculoskeletal ill health (142); these results should be confirmed in further population studies.

In Papers II and III, we observed a strong education gradient on sickness absence risk. In Paper I, the effect of education was somewhat weaker than expected, especially for men, and the reasons for this are not clear. However, most studies have used self-reported

measures as psychiatric outcomes, and only a few have used registry-based sickness absence data.

Recent randomised intervention studies have demonstrated that the screening of employees (with high risk of sickness absence) by an occupational health assessment followed by an intervention might yield a 30-40% reduction in the number of sickness absence days (143-144). Presently, there is relatively limited documentation available concerning the effect of workplace intervention on sickness absence (56). To our knowledge, no studies have yet examined the impact of working conditions linked to registry data on comparable interventions on the registry-based risk of sickness absence. In Denmark, the government has introduced a national return-to-work (RTW) program that aims to improve the management of municipal sickness benefits. The program includes 21 municipalities encompassing approximately 19,500 working-age adults on long-term sickness absence (36); the first results will be available in 2013.

In Paper III, we found that IW participation varied by industry. Among women in IW companies compared with non-IW companies, a larger proportion worked in the health sector, had shift or night work, or heavy physical work. In addition, there were systematic differences between the IW and non-IW groups in these variables for men. The labour market in Norway is highly gender segregated. Work tasks and working conditions may differ substantially between the genders or between female- and male-dominated occupations. Most enterprises in public industries, including the health sector, have entered into the IW-agreement. IW companies with demanding work and high rates of absence may have had more interest in the IW-agreement. Thus, industry may act as a confounder on the association between IW participation and LSA. IW and non-IW persons differ systematically by demographic characteristics and work environment. This is a challenge in interpreting the results. In addition, there are reasons to believe that not all enterprises with an IW-agreement have achieved the IW intentions, and many non-IW businesses may have implemented sickness absence reduction efforts. These issues demonstrate an important aspect of the complexity of studying sickness absence. A low educational level was highly predictive of LSA, especially for men. Interventions for preventing LSA should be especially targeted to these groups.

The IW-agreement has primarily focused on reducing the level of sickness absence through measures designed to help the sick listed return to work (secondary prevention) (56). From a work-related perspective, the focus should be on developing strategies to avoid workers dropping out of the labour market rather than focusing on how to get them back into work (return to work); this is also assumed to be a more economic strategy. There is a need for more sector-specific strategies, as different sectors are concerned with various workloads and sector-specific needs for absence. The IW-agreement should also be increasingly differentiated by business size, as this provides different conditions for conducting IW work.

Additional analyses

We performed multivariate regression models on disability pension as outcome measure for psychiatric and musculoskeletal diagnoses. We also analysed the disability risk for IW and non-IW persons. The precision of association estimates is reflected in the confidence intervals, and we concluded that our population was too small and therefore too weak with regard to statistical power to look at disability, as it was a less common outcome.

External validity

Our study is based on Oslo citizens, aged 30, 40, 45 (Papers I-II) and 60 years (included in Paper III only). Because HUBRO was restricted to a few age cohorts, people not included in these age groups may differ from those included in the study. Sickness absence is a construct of modern Western societies, and the criteria for getting financial support varies a lot in time and space, as it depends on traditions, culture and legislation. Employees with a certified sickness absence receive full salary in Norway for a maximum period of 1 year. It is not clear how nation-specific regulations influence the associations between individual and work-related factors and sickness absence. However, we cannot reject limitations on the

generalisability of this thesis, and extending the interpretations to other countries should therefore be done with caution.

Conclusions and implications

In this prospective study, with both self-reported and registry-based data, we have demonstrated the importance of the interplay between individual and occupational factors to achieve a deeper understanding of the underlying causes for long-term sickness absence.

We report large gender differences and social inequalities in the sickness absence risk. Well-known psychosocial and physical work factors were found to be associated with sickness absence. Distinctive psychosocial and physical work factors were found as risk factors according to gender and diagnoses. Sickness absence due to psychiatric and musculoskeletal diagnoses is a public health problem with serious consequences for the individual. Improving working conditions such as social support may be an important step towards reducing the burden of sickness absence due to mental health problems. Despite the great transitions working life has undergone in recent decades, with an increase in automation and a change to more sedentary work, shift, physical and strenuous work are still important predictors of sickness absence with musculoskeletal disorders. Among women in IW companies compared with non-IW companies, a larger proportion worked in the health sector, had shift or night work, or heavy physical work. In addition, there were systematic differences between the IW and non-IW groups in these variables for men. Low educational level was highly predictive of LSA, especially for men. Interventions for preventing LSA should be especially targeted to these groups. However, this study could not demonstrate a significantly lower risk of LSA in companies signing the IW-agreement.

It is often implicitly assumed that there should be as little sickness absence as possible, but this is not always desirable from an inclusive working life perspective. Still, the proportion of absence due to preventable causes such as work related factors influencing health negatively should be reduced, and more and better knowledge is needed in order to make effective interventions and prevention programs to reduce sickness absence. Registry data on sickness absence linked to information on diagnoses and self-reported data from health surveys, including information on both the individual and work-related level, as we have

done in this study, contributes to increased understanding of these relationships. A broad approach that focuses on individuals as well as work-related factors is necessary for preventing sickness absence and disability pensioning and reducing the still large social in equalities in health.

Our results do not contrast with accepted understanding, even though our results require interpretation and are highly dependent on the choice of model. There is a possibility for unmeasured confounding in our study, which could give biased results. Further research in the sickness absence field should especially focus on minimising this unknown effect.

More research is needed with registry data on sickness absence as outcome measure. Due to the often-observed gender differences in sickness absence, future research should include both genders to explore these matters further. Both psychosocial and physical factors should be examined together to evaluate their relative importance and by evaluating how they may interact with each other. These factors should have precedence in intervention programs and be addressed when occupational health services give advice on preventive measures.

In the sickness absence research field, concepts and their definitions are still to a limited extent standardized, and more and better definitions need to be provided. Further research should use stronger study designs and more concise definitions of sickness absence.
We also propose that future research should include the development of measures designed for studying workplace exposure across different countries. This could provide a more systematic overview of knowledge that can be applied to prevention.

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I

II

III

"Inclusive working life in Norway": a registry-based five-year follow-up study

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ABSTRACT

Background— In 2001, the Norwegian authorities and major labour market partners signed an agreement regarding 'inclusive working life' (IW), whereby companies that participate are committed to reducing sickness absence.

Aims— To determine the effect of the IW program and other work characteristics by gender on long-term (>8 weeks) sickness absence (LSA).

Methods— Self-reported data on work characteristics from the Oslo Health Study were linked to registry-based data on IW status, education and LSA. From 2001-2005, 10,995 participants (5,706 women and 5,289 men) aged 30, 40, 45 and 60 years were followed. A Cox regression was used to compute hazard ratios (HR) for LSA risk. The cohort was divided into an IW group (2,733 women and 2,058 men) and non-IW group (2,973/3,231).

Results—43.2 % and 41.6 % of women and 22.3 %/24.3 % of men (IW / non-IW, respectively) experienced at least one LSA. In a multivariate model, statistically significant risk factors for LSA were low education (stronger in men), shift work/night work or rotating hours (strongest in men in the non-IW group), and heavy physical work or work involving walking and lifting (men only and stronger in the non-IW group). Among men who engaged in shift work, the LSA risk was significantly lower in the IW group.

Conclusions—Our results could suggest that IW companies that employ many men in shift work have implemented relevant efforts for reducing sickness absence. However, this study could not demonstrate a significant effect of the IW program on the overall LSA risk.

INTRODUCTION

Developing methods to address growing challenges from long-term sickness absence is a major public health issue. The reduction in sickness absence rates has received significant attention in Europe in recent years primarily because of the high costs of sickness absence to businesses and society (1). Sickness absence represents a burden and challenge to people who wish to work, employers, the health care sector and society as a whole (2;3). Work environment factors are important determinants of sickness absence (4;5) and disability pension (6).In Norway, reducing sickness absence and disability is an important political objective. Since October 2001, these efforts are regulated through the Inclusive Working Life (IW) program, a Norwegian national intervention program implemented by authorities and major labour market partners. Under the IW agreement, participating businesses commit to working to reduce sickness absence, reduce the number of individuals leaving the labour market on a disability pension, and include the elderly and individuals with disabilities into working life (7). The agreement has been renewed three times, most recently throughout 2013. As of December 2012, the agreement covers approximately 25 % of all Norwegian enterprises and 57 % of all employees.

The IW program represents a new approach to preventing sickness absence, which includes a closer follow-up of the cases. The solutions are anchored in the viewpoint that the workplace is an important arena for organising efforts aimed at reducing sickness absence. The government approves financial support to IW enterprises and assists in strengthening support services for any employers in need of supervision and workplace adjustment. Rather than leaving all the responsibility for health management to the physicians and patients, a dialogue between the employer and employee is fostered, and assistance from the occupational health service is sought. An evaluation of the person's level of functioning determines how they can contribute at work, and the workplace should accommodate the person's level of functioning.

Long-term sickness absence and disability pension may be viewed as health-related selection out of working life. Long-term sickness and disability pension both increase with age and are more frequent among individuals with a low socioeconomic position (SEP) (8;9). Strong associations between indicators of ill health and sickness absence have been found, particularly for longer periods of absence, and long-term absence is associated with increased mortality risk (10). A substantial portion of individuals with long-term sickness absences never return to work but end up with a permanent disability pension (11). Thus, understanding the reasons individuals become sick-listed is an important issue, and there is a need for more studies investigating the causes of sickness absence.

The objective of this longitudinal, population-based cohort study was to examine gender-specific associations between work-related factors, SEP and long-term (>8 weeks) sickness absence (LSA) in IW and non-IW persons. Our specific aim was to reveal any differences according to IW status in the associations between work characteristics and LSA and determine whether the IW program had an effect on LSA. To our knowledge, no other studies have examined the impact of working conditions on the risk of registry-based sickness absence linked to registry data on IW status or other similar interventions.

METHODS

The Oslo Health Study (Norwegian abbreviation: HUBRO) was conducted from 2000–2001 as a collaboration between the Norwegian Institute of Public Health, University of Oslo and Municipality of Oslo (12). The survey included all inhabitants in Oslo aged 30, 40, 45, 60 and 75 years, for a total of 40,888 persons. The response rate was 46 %, yielding a study sample of 18,770. The HUBRO survey included several questionnaires: a main questionnaire presented to all and a series of supplementary questionnaires given to different age groups containing questions on personal, social, health and work-related topics. In this study, the information regarding working conditions and health were compiled from these self-reported data and our analyses were restricted to 10, 995 respondents in the age groups of 30, 40, 45 and 60 years.

The HUBRO responses were linked to the Historical Event Database of Statistics Norway (Norwegian abbreviation: FD-Trygd) (13), which contains national social insurance information covering the entire population through several linked official registers based on a unique, 11-digit personal identification number.

In Norway, full economic compensation is given from the first day of sickness absence to persons with a pensionable income above the sickness allowance limit, which was 5,300 Euro per year as of May 2011. We collected data on the first spell of LSA among the 10,995 participants (5,706 women and 5,289 men) at risk of sickness absence on January 1st, 2001. Persons not at risk were excluded from the analyses. Those not at risk were defined by one of the following non-mutually exclusive conditions: death, emigration, the receipt a disability pension before the start of follow-up, a pensionable income in 2001 below the sickness absence entitlement limit, or a sickness absence on January 1st, 2001.

The Regional Committee for Medical Research Ethics approved this study.

The dichotomous study outcome was having at least one spell of a long-term (>8 weeks), continuous sickness absence during the five-year period from 2001-2005.

The cohort was divided into IW and non-IW groups. Serial numbers from the Norwegian Labour and Welfare Administration`s IW registry were linked to individual data from HUBRO and FD-Trygd. An "IW employee" was defined as a person employed in an IW enterprise after the agreement was enacted in 2001. Following this definition, 4,791 (2,733 women and 2,058 men) were IW employees (43.6%). The remaining 2,973 women and 3,231 men were classified as non-IW employees.

The SEP indicator was based on the education level classifications from Statistics Norway (14) and categorised into five levels.

We made the following industry group categorisation based on the Standard Industrial Classification (SIC2002) by Statistics Norway (15): (1) secondary industry (industry, building / construction, etc., SIC2002 codes 10 – 45), (2) tertiary industry, heavy (retail, hotel / restaurant, transport / storage / communication, SIC2002 codes 50 – 64), (3) office work (service trades / insurance, civil service, SIC2002 codes 65 – 75), (4) the teaching sector (SIC2002 code 80), (5) the health sector (health and social care, social services, SIC2002 codes 85 – 93) and (6) other/unknown (SIC2002 codes 00 – 05, 95 – 99).

The following work-related variables were included in the present analyses: *The work schedule* variable was based on the question, "*Do you do shift work, night work or have rotating hours of work?"* The response categories were *Yes* or *No. Physical job demands* were measured by the question*, "If you have paid work or do unpaid work, how would you describe your work?* Responses were as follows: (one cross only) *Mainly sedentary work? ; Work involving a lot of walking?; Work involving a lot of walking and lifting?;* or *Heavy physical work?*" The two last categories were merged into one category.

Stata/SE 11.2 was used for the analyses. Cox proportional hazards models were used to compute the LSA hazard ratios (HR) and corresponding 95 % confidence intervals (CI). We adjusted for age, education, industrial classification and the job exposure variables. All analyses were stratified by gender, and the main analyses were additionally stratified by IW status. We additionally performed a gender-stratified Cox regression to estimate the relative IW effect. Gender-stratified models were estimated in certain subgroups in which the results indicated heterogeneity. The follow-up lasted until the end of 2005. Censoring occurred when individuals died, emigrated or received a disability pension or early retirement during the follow-up period. Of the total sample, 776 persons were censored.

RESULTS

A total of 3,663 employees experienced at least one LSA during the five-year follow-up period (risk 0.333). Table 1 shows the 5-year risk of an LSA by age, education, industrial classification and work-related factors stratified by gender and IW status. Women had a higher risk than men of experiencing an LSA, but the gender-specific differences by IW groups were generally small. For men, there was a strong, positive relationship between age and LSA risk, whereas for women, the youngest age cohort had the highest LSA risk. There was a strong education gradient for both genders, but the education gradient was more pronounced for men.

Among women in IW companies compared with non-IW companies, a larger proportion worked in the health sector (38.5 % vs. 21.4 %), had shift or night work (19.3 % vs. 9.2 %), or heavy physical work (15.8 % vs. 9.1 %), while a lower proportion was 60 years of age (19.6 % vs. 25.5 %). In addition, there were systematic differences between the IW and non-IW groups in these variables for men.

Women working in the health sector had the highest LSA risk. For men with IW employment, the highest LSA risk was observed in secondary industry, heavy tertiary industry and the health sector. For men in the non-IW group, the highest LSA risk was observed in heavy tertiary industry. Having shift work, night work or rotating hours had a strong association with the LSA risk and was strongest among men in the non- IW group. The LSA risk for persons with heavy physical work and work involving a lot of walking and lifting was 30 % higher in women and more than doubled in men compared with women and men with sedentary work.

Tables 2 and 3 show the results from the Cox regression according to crude and adjusted associations for the IW and non-IW groups and women and men, respectively. The effect of age on LSA risk was stronger in men in the fully adjusted model. The youngest women had the highest LSA risk. In the fully adjusted model, the statistically significant risk factors for LSA were low education (stronger in men, especially in the IW group), shift work/night work or rotating hours (non-significant for men in

the IW group and strongest in men in the non-IW group), heavy physical work or work involving significant walking and lifting (men only and strongest in the non-IW group).

The gender-stratified Cox regressions estimating the relative IW effect showed a significant effect for men in the crude analysis (HR for the IW group, with non-IW as reference: 0.88, 95 % CI 0.79 – 0.99). This effect disappeared in the multivariate analysis (HR 0.97, 95 % CI 0.86 – 1.09). In women, the HR was 1.02 (non-significant) in both the crude and adjusted analyses. We performed a separate analysis for shift working men. The adjusted HR for an LSA was significantly lower in the IW group (HR 0.67, 95 % CI 0.51 – 0.88). For men in the teaching sector, IW employment appeared to have a protective effect compared with men without IW employment (table 1). However, the corresponding adjusted HR was close to unity (0.91; 95 % CI 0.56 – 1.48). We did not find any significant IW effect in other subgroups, such as men with heavy physical work or younger men. For women, the adjusted HRs were close to unity for all industries.

DISCUSSION

Approximately 43/42 % of the women and 22/24 % of the men working for IW and non-IW companies, respectively, had an LSA in the 5 years following the health survey. In a multivariate model, the statistically significant risk factors for an LSA were shift work/night work or rotating hours (non-significant for men in the IW group and strongest in men in the non-IW group) and heavy physical work or work involving a lot of walking and lifting (men only and strongest in the non-IW group). When estimating the IW effect for gender separately, we found no significant results after adjustment. However, the LSA risk of men working shift/night or rotating hours was significantly lower in the IW group.

The strengths of this study are a relatively large population-based sample, using register-based data on sickness absence and a longitudinal study design. Studies of work characteristics and health have been criticised on methodological grounds for an undue reliance on self-reported outcome measures and not addressing information bias (16). The basic source of a dependent error (17) in such studies is usually a normal variation in certain personality traits, but the error may additionally be in more transitional moods in the study population or inadequate measurement tools. Registry-based rates of physician-certified sickness absence may be a more accurate measure of health status than self-reports, which are often biased (18). The major precaution that should be taken to eliminate bias from dependent error is to break the bond between information on exposure and outcome by gathering data from two separate sources (19), which is what was done in this study. Additionally, the data on educational level were objective information from public registries. The low participation rate (46 %) in HUBRO may have led to the self-selection of healthy subjects into the study. The predictors of participation and magnitude and direction of the non-response bias in prevalence estimates and association measures have been investigated based on information from all 40,888 invitees to the Oslo Health Study. The potential selection bias was studied by linking register-based data from Statistics Norway on demographics, and social security benefits to the entire study

population. Unhealthy persons participated to a lesser degree than healthy individuals, but the social inequality in health by different socio-demographic variables appeared unbiased (20). In addition, the response rate to the supplementary questionnaires on working conditions was lower in subgroups with worse health (21). Because poor health often is associated with a poor work environment, this finding may imply a lower response among subjects with poor work environments and thus conservative estimates of the effects of working conditions on LSA.

In this study, the participants were categorized into an IW and a non-IW group. Principally, this is a dynamic variable, since people change jobs, and workplaces could change IW status over time. We therefore tried to work this variable out as a time dependent variable, classifying all sick leaves as IW leaves or non-IW leaves. However, this was not possible. We had the date for inclusion into the IW agreement for the companies, but a severe limitation was that the earliest date registered was March 2003, although the agreement was initiated in 2001. All companies included in the agreement in the period 2001 - March 2003 were given the date March 2003. By that reason, we could not categorize sick leaves in this period in an insuring way. We also intended to divide the study persons into three groups: those employed in an IW enterprise all the period, those never employed in an IW enterprise and, finally, those employed in an IW enterprise parts of the period. Neither this was possible by the same reasons, and we ended up with a dichotomization.

Women exhibited a higher LSA risk than men, but the associations between a high physical workload and shift/night work and LSA risk were stronger for men than for women. Women working in the health sector had the highest LSA risk. The health sector is dominated by demanding work, such as hard physical work and shift and night work. Most enterprises in public industries, including the health sector, are IW enterprises. Some IW companies may have levels of high sickness absence and absenteeism because the workload is more demanding, which might have led to more interest in the IW agreement. We likely have elements of reverse causation in that high sickness absence levels in a company might have acted as an incentive to participate in the IW program. This is a plausible

interpretation in cases in which the program was adopted late in the 2001-2005 period. The IW participation varies by industry. As an example, 62 % of women in the health sector were in IW companies, compared with only 32 % in the heavy tertiary industry (table 1). Thus, industry may act as a confounder on the association between IW participation and LSA. IW and non-IW persons differ systematically by demographic characteristics and work environment. This is a challenge in interpreting the results. In addition, there are reasons to believe that not all enterprises with an IW agreement have achieved the IW intentions, and many non-IW businesses may have implemented sickness absence reduction efforts widely. Several measures that have arisen in the wake of the IW agreement are directed toward the entire working life, such as new sick leave rules, training of physicians and more dialogue between employers and sick-listed employees. Because no impact on the national sickness absence rates was observed by 2004, the government and social partners realised that there was a need to involve a patient's physician because general practitioners issued approximately 80 % of sickness absence certificates (1). Since 2004, the physicians' sickness absence certificates have been replaced by a "work ability certificate" to promote an early return to work. Sickness absence from work has gained more attention in the society as a whole after the IW agreement was implemented, which has affected the follow-up work for absentees in the entire labour market. These issues might additionally explain the lack of contrasts between the IW and non-IW groups. Many EU governments have introduced programmes aimed at encouraging long-term absentees back into work. There is still relatively limited documentation concerning the effect of workplace interventions on sickness absence (22).

The labour market in Norway is highly gender segregated. Studies have shown that occupational groups dominated by one gender have higher levels of absence (23;24). Work tasks and working conditions may differ substantially between the genders or between female- and male-dominated occupations. A low educational level was highly predictive of LSA, especially for men. Interventions for preventing LSA should be especially targeted to these groups.

Despite the great transitions working life has undergone in recent decades, with an increase in automation and a change to more sedentary work, shift and strenuous work are still important predictors of sickness absence. Due to the often-observed gender differences in LSA, future research should include both genders to explore these matters further. Future research should additionally focus on the work environments that might be responsible for these factors.

Conflicts of interest

The Authors declares that there is no conflict of interest.

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Table 1. Risk of long-term sickness absence (LSA) among participants in the Oslo Health Study with follow-up 2001–2005, stratified on IW-status and gender, according to potential determinants.

	Women (N=5706)				Men (N=5289)			
	IW (N=2733)		Non- IW (N=2973)		IW (N=2058)		Non- IW (N=3231)	
	Per cent of total	LSA risk	Per cent of total	LSA risk	Per cent of total	LSA risk	Per cent of total	LSA risk
Total	100	0.432	100	0.416	100	0.223	100	0.243
Age								
30	31.0	0.485	30.9	0.459	31.1	0.138	29.9	0.174
40	26.0	0.389	22.3	0.374	24.9	0.223	21.7	0.254
45	23.4	0.399	21.2	0.374	23.2	0.262	19.4	0.254
60	19.6	0.444	25.5	0.437	20.8	0.312	29.0	0.300
Education*								
1	5.3	0.507	8.8	0.502	6.7	0.449	8.2	0.395
2	20.3	0.459	23.3	0.457	12.9	0.342	17.1	0.326
3	16.8	0.472	20.3	0.430	19.6	0.278	25.8	0.281
4	37.2	0.441	33.0	0.391	30.9	0.171	28.8	0.176
5	17.7	0.313	11.3	0.304	27.1	0.117	16.3	0.110
Missing	2.7	0.479	3.4	0.470	2.8	0.345	3.7	0.378
Industrial classification								
Secondary industry	3.7	0.363	6.1	0.383	7.7	0.302	13.9	0.267
Tertiary industry (heavy)	9.1	0.430	17.5	0.437	16.4	0.260	20.3	0.290
Office work	24.3	0.386	23.4	0.407	33.8	0.172	26.9	0.157
Teaching sector	7.7	0.386	11.6	0.391	7.4	0.203	4.7	0.255
Health sector	38.5	0.484	21.4	0.447	16.3	0.262	7.7	0.222
Missing	16.7	0.416	20.1	0.402	18.3	0.223	26.5	0.287
Shift work, night work or rotating hours?								
No	66.7	0.392	76.9	0.392	65.9	0.192	73.2	0.215
Yes	19.3	0.530	9.2	0.511	18.2	0.261	10.1	0.374
Missing	14.0	0.483	13.9	0.488	15.8	0.307	16.7	0.289
Physical job demands								

Mainly sedentary	50.9	0.383	53.4	0.380	56.0	0.162	53.7	0.176
Involving significant walking	18.9	0.462	22.7	0.432	16.7	0.271	16.3	0.294
Heavy physical work or work involving significant walking and lifting	15.8	0.506	9.1	0.507	11.1	0.364	12.8	0.403
Missing	14.3	0.483	14.8	0.469	16.3	0.287	17.1	0. 288

*Level of education was collapsed into five categories: Primary education/Lower secondary (1) Upper secondary education, basic (2) Upper secondary, final year/post-secondary non-tertiary education (3) First stage of tertiary education, undergraduate level (4) First stage of tertiary education, graduate level/postgraduate education (5)

Table 2. Hazard ratios (HR) of long-term sickness absence (LSA) (>8 weeks) among participants in the Oslo Health Study with follow-up 2001-2005, stratified on IW-status, according to potential determinants. Women

	Crude IW		Adjusted [a] IW		Crude Non-IW		Adjusted [a] Non- IW	
	HR	95%CI	HR	95%CI	HR	95%CI	HR	95%CI
Age								
30	1	Reference	1	Reference	1	Reference	1	Reference
40	0.8	0.7-0.9	0.7	0.6-0.8	0.8	0.7-0.9	0.7	0.6-0.9
45	0.8	0.7-0.9	0.7	0.6-0.8	0.8	0.6-0.9	0.7	0.6-0.8
60	1.0	0.8-1.2	0.9	0.7-1.0	1.1	0.9-1.2	0.9	0.8-1.1
Education*								
1	2.0	1.5-2.6	2.0	1.5-2.7	2.0	1.6-2.6	2.1	1.6-2.7
2	1.7	1.4-2.1	1.7	1.4-2.1	1.7	1.4-2.2	1.8	1.4-2.3
3	1.7	1.4-2.1	1.7	1.4-2.1	1.5	1.2-1.9	1.5	1.2-1.9
4	1.5	1.3-1.8	1.5	1.2-1.8	1.4	1.1-1.7	1.3	1.1-1.7
5	1	Reference	1	Reference	1	Reference	1	Reference
Missing	1.8	1.3-2.6	1.7	1.2-2.5	2.1	1.5-3.0	2.0	1.4-2.8
Industrial classification								
Secondary industry	1.2	1.0-1.5	0.9	0.7-1.2	1.1	0.9-1.3	0.9	0.8-1.1
Tertiary industry (heavy)	0.9	0.7-1.3	0.8	0.6-1.2	0.9	0.7-1.2	0.9	0.7-1.1
Office work	1	Reference	1	Reference	1	Reference	1	Reference
Teaching sector	1.0	0.8-1.3	1.0	0.8-1.4	1.0	0.8-1.2	1.0	0.8-1.2
Health sector	1.3	1.1-1.5	1.1	0.9-1.3	1.1	1.0-1.3	1.0	0.8-1.2
Missing	1.1	0.9-1.3	1.0	0.8-1.2	1.0	0.8-1.2	0.9	0.8-1.1
Shift work, night work or rotating hours?								
No	1	Referencw	1	Reference	1	Reference	1	Reference
Yes	1.5	1.3-1.7	1.3	1.1-1.5	1.5	1.2-1.7	1.2	1.0-1.5

Missing	1.3	1.1-1.5	1.1	0.8-1.5	1.3	1.1-1.5	1.4	1.0-1.9
Physical job demands								
Mainly sedentary	1	Reference	1	Reference	1	Reference	1	Reference
Involving significant walking	1.3	1.1-1.5	1.1	0.9-1.3	1.2	1.0-1.3	1.2	1.0-1.4
Heavy physical work or work involving significant walking and lifting	1.5	1.2-1.7	1.1	0.9-1.3	1.5	1.3-1.8	1.3	1.0-1.6
Missing	1.3	1.1-1.6	1.1	0.8-1.6	1.3	1.1-1.5	1.0	0.7-1.3

a Adjusted for education, industrial classification, shift work/night work and physical job demands
*Level of education was collapsed into five categories: Primary education/Lower secondary (1) Upper secondary education, basic (2) Upper secondary, final year/post-secondary non-tertiary education (3) First stage of tertiary education, undergraduate level (4) First stage of tertiary education, graduate level/postgraduate education (5)

Table 3. Hazard ratios (HR) of long-term sickness absence(LSA) (>8 weeks) among participants in the Oslo Health Study with follow-up 2001-2005, stratified on IW-status, according to potential determinants. Men

	Crude IW		Adjusted [a] IW		Crude Non-IW		Adjusted [a] Non- IW	
	HR	95%CI	HR	95%CI	HR	95%CI	HR	95%CI
Age								
30	1	Reference	1	Reference	1	Reference	1	Reference
40	1.7	1.3-2.2	1.4	1.0-1.8	1.5	1.2-1.9	1.3	1.1-1.7
45	2.0	1.5-2.6	1.7	1.3-2.2	1.5	1.2-1.9	1.4	1.1-1.7
60	2.6	2.0-3.4	2.3	1.7-3.0	2.0	1.7-2.5	1.9	1.6-2.3
Education*								
1	4.6	3.3-6.5	3.3	2.2-4.9	4.4	3.2-6.0	2.9	2.0-4.0
2	3.3	2.4-4.6	2.7	1.9-3.9	3.4	2.5-4.5	2.3	1.7-3.1
3	2.6	1.9-3.5	2.4	1.7-3.3	2.8	2.1-3.7	2.3	1.7-3.1
4	1.5	1.1-2.1	1.5	1.1-2.0	1.7	1.2-2-2	1.6	1.2-2.1
5	1	Reference	1	Reference	1	Reference	1	Reference
Missing	3.7	2.2-6.1	3.4	2.0-5.8	4.7	3.2-7.0	3.8	2.5-5.7
Industrial classification								
Secondary industry	1.6	1.2-2.1	1.0	0.7-1.3	2.0	1.6-2.5	1.3	1.0-1.6
Tertiary industry (heavy)	1.9	1.4-2.7	1.2	0.9-1.8	1.8	1.4-2.3	1.1	0.9-1.5
Office work	1	Reference	1	Reference	1	Reference	1	Reference
Teaching sector	1.2	0.8-1.8	1.3	0.9-2.0	1.7	1.2-2.5	1.8	1.2-2.6
Health sector	1.6	1.2-2.1	1.3	1.0-1.7	1.5	1.1-2.0	1.2	0.9-1-7
Missing	1.3	1.1-1.8	1.0	0.7-1.3	2.0	1.6-2.4	1.5	1.2-1.8
Shift work, night work or rotating hours?								
No	1	Reference	1	Reference	1	Reference	1	Reference
Yes	1.4	1.1-1.8	1.1	0.8-1.4	1.9	1.6-2.3	1.6	1.3-2.1

Missing	1.7	1.3-2.1	2.4	1.2-4.6	1.4	1.2-1.7	1.2	0.8-1.8
Physical job demands								
Mainly sedentary	1	Reference	1	Reference	1	Reference	1	Reference
Involving significant walking	1.8	1.4-2.3	1.3	1.0-1.7	1.8	1.5-2.2	1.3	1.0-1.5
Heavy physical work or work involving significant walking and lifting	2.5	1.5-2.4	1.6	1.2-2.1	2.6	2.1-3.1	1.8	1.5-2.2
Missing	1.9	1.5-2.4	0.7	0.3—1.3	1.7	1.4-2.1	1.3	0.9-2.0

a Adjusted for education, industrial classification, shift work/night work and physical job demands
*Level of education was collapsed into five categories: Primary education/Lower secondary (1) Upper secondary education, basic (2) Upper secondary, final year/post-secondary non-tertiary education (3) First stage of tertiary education, undergraduate level (4) First stage of tertiary education, graduate level/postgraduate education (5)