National Institute of Occupational Health

UNIVERSITY OF OSLO

Work-related health problems in the population

Impact of working conditions on health and on social inequalities in musculoskeletal pain among Oslo citizens aged 30–45 years

Ingrid Sivesind Mehlum

Department of Occupational Medicine and Epidemiology

National Institute of Occupational Health, Oslo

Faculty of Medicine

University of Oslo

2010

Series of dissertations submitted to the
Faculty of Medicine, University of Oslo
No. 888

ISBN 978-82-8072-563-9

Cover: Inger Sandved Anfinsen.
Printed in Norway: AiT e-dit AS, Oslo, 2010.

Produced in co-operation with Unipub AS.
The thesis is produced by Unipub AS merely in connection with the
thesis defence. Kindly direct all inquiries regarding the thesis to the copyright
holder or the unit which grants the doctorate.

Unipub AS is owned by
The University Foundation for Student Life (SiO)

Contents

1 Acknowledgements

I am thankful I was given the opportunity to perform the research work leading towards this thesis at the Norwegian Institute of Occupational Health (NIOH) in the period 2000–2009. The primary data collection was conducted as part of the Oslo Health Study 2000–2001, in collaboration with the Norwegian Institute of Public Health, which also administered the invitations to the subjects included in Paper III. I thank all who participated in the Oslo Health Study, without whom this thesis would not have been.

The study was supported financially by the Confederation of Norwegian Business and Industry's Working Environment Fund, and the Directorate of Labour Inspection. I also want to thank the NIOH for financial support in periods.

I am grateful to all who have encouraged, helped, supported, and otherwise contributed to this work.

First, to Helge Kjuus, my main supervisor and head of the Department of Occupational Medicine and Epidemiology, for your mild guidance, clarifying discussions, and wise advice. Besides, I thank you for all the other interesting tasks you gave me while I was working on this project, which, no doubt, made my progress slower, but also gave me valuable insight into these fields of research.

I will also thank my co-supervisors:
Ebba Wergeland, for conceiving of the study, for encouraging me to start this project, although it meant that you would lose me as a colleague at the Labour Inspection Authority, and for never missing an opportunity to make a manuscript more precise.

Bo Veiersted, for sharing your valuable expertise in the field of musculoskeletal disorders, and for being a patient discussion partner on how to apply the criteria of the criteria document, over and over again.

I will thank my co-authors:
Petter Kristensen, co-author on Paper II, and a very experienced one, without whom I would hardly have dared to enter the large research field of socio-economic inequalities.

Morten Wærsted, co-examiner and co-author on Paper III, a sharp and pleasant colleague, who more than once asked the good and clarifying questions.

Thanks also to all my other colleagues at the NIOH, and especially those at the Department of Occupational Medicine and Epidemiology, for a supportive work environment, interesting discussions, and cheerful lunches. I want to thank Stein and Tor Martin, for quick IT support, and the librarians (Nina, Line, Kirsti, and Berit) for providing literature and helping with RefMan and Metalib.

I also want to thank my former colleagues at the Labour Inspection Authority and other colleagues elsewhere, for challenging and inspiring meetings and discussions.

And last, but not least, I want to thank my family. My late father, who would have liked to read my thesis, and my mother who certainly does, for their interest in my work. I want to thank you, my dear Lars, for showing me the way. I may never have thought of going into research without you doing it first. Thanks also for giving me your experienced advice, interesting discussions, and support throughout these years. And finally, warm thanks to you, Maria, Camilla, and Julie, for reminding me of the important things in life.

2 English summary

Background

Lack of knowledge about the occurrence of work-related health problems in the general population makes it difficult to estimate the potential for their prevention in the workplace. The impact of working conditions on socio-economic inequalities in health also needs to be further explored. Although self-reported data is often used to follow population trends in work-related illness, the use of such data as a measure of work-related illness in the population has often been considered with scepticism, assuming this would give exaggerated estimates.

Aims

The aims of this thesis were to investigate the occurrence and distribution of work-related health problems in the population and the impact of working conditions on health. The more specific objectives were to: (1) examine the prevalence and distribution of self-reported work-related health problems and their impact on the burden of ill-health among Oslo citizens aged 30, 40, and 45 years; (2) quantify socio-economic inequalities in the occurrence of self-reported low back pain, neck/shoulder pain, and arm pain in the general working population in Oslo, and examine the impact of job characteristics on these inequalities; and (3) compare self-reported work-relatedness of neck/shoulder pain and arm pain with experts' assessments based on specific criteria.

Study populations and methods

The study was part of the Oslo Health Study 2000–2001, in which all individuals in certain age cohorts were invited to a comprehensive health screening. All 30-, 40-, and 45-year old subjects who attended the screening were asked if they had experienced any of eleven common health problems in the past month, and whether they considered these to be totally or partially work-related. Of the 26 074 invited subjects in the three age cohorts, 8 594 (33 %) answered the questionnaire, and were included in Paper I.

All employed subjects who attended the Oslo Health Study and answered questions on physical job demands, job autonomy, and musculoskeletal pain were included in Paper II (N = 7 293). Occupational class was used as an indicator of socio-economic position.

The lower occupational classes were compared to higher grade professionals, and prevalences, prevalence ratios (PR), prevalence differences (PD), and population attributable fractions (PAF) were calculated.

A sample of 217 employed participants in the Oslo Health Study, who reported neck/shoulder or arm pain in the past month, underwent a health examination at the Norwegian Institute of Occupational Health, and were included in Paper III. A criteria document for evaluating the work-relatedness of upper-extremity musculoskeletal disorders was used to establish clinical diagnoses and assess the work-relatedness of pain with respect to the subject's present job. Agreement between the participants and experts on whether pain was related to work, was measured as observed agreement, positive and negative specific agreement, and kappa.

Results

In this study, self-reported work-related health problems were highly prevalent. Nearly 60 % reported one or more work-related health problem, and a high proportion of reported health problems were attributed to working conditions, especially musculoskeletal pain and fatigue. There were small age differences, but marked gender differences in this population, with higher frequencies among women for many of the health problems.

Among the 7 293 employed subjects, there were marked, socio-economic gradients in musculoskeletal pain, steeper in men than in women. The differences on an absolute scale (PD) were larger for low back pain than for neck/shoulder pain and arm pain. Job characteristics explained approximately ⅓ – ½ of the prevalence differences in low back pain (both genders) and neck/shoulder pain (men) between higher grade professionals compared to skilled and non-skilled workers. Physical job demands explained a substantial proportion of social inequalities in low back pain, while job autonomy was more important in explaining inequalities in neck/shoulder pain and arm pain. Estimates of population attributable fractions (PAF) supported the impact of these two job characteristics on the social differences in musculoskeletal pain in the working population, especially for low back pain.

In the comparative study among 217 subjects who reported neck/shoulder pain or arm pain in the past month, cases were somewhat more frequently assessed as work-related by the subjects than by the experts. However, there was considerable disagreement as to which

cases were work-related. There was more agreement on arm than neck/shoulder pain and generally more on cases assessed as work-related, as opposed to non-work-related ones, particularly in men. Agreement will depend on the case definitions and the criteria for work-relatedness used by both participants and experts.

Conclusions

The high prevalences of self-reported work-related health problems suggest a large potential for prevention of common health problems in the population by modification of known risk factors in the workplace. If the associations observed between job characteristics and musculoskeletal pain are causal, the results indicate that interventions to reduce heavy physical work and lifting, and increase job autonomy may reduce social inequalities in the occurrence of musculoskeletal pain. Self-reporting did not seem to particularly exaggerate work-relatedness. Thus, self-reported data in population surveys may be used more confidently, not only to follow population trends in work-related illness, but also as a rough measure of work-related illness in the population, at least for pain in neck/shoulder and arm.

3 Norsk sammendrag

Bakgrunn

Mangel på kunnskap om forekomst av arbeidsrelaterte helseproblemer i befolkningen gjør at det er vanskelig å anslå potensialet for forebygging på arbeidsplassen. Det er også behov for mer kunnskap om betydningen av arbeidsforhold for sosiale ulikheter i helse. Selv om selvrapporterte data ofte brukes for å følge *utviklingen* i arbeidsrelatert sykdom på befolkningsnivå, har man vært skeptisk til bruk av slike data som *mål på arbeidsrelatert sykdom* i befolkningen og ment at man da ville få for høye tall.

Mål

Målet med denne avhandlingen var å studere forekomst og fordeling av arbeidsrelaterte helseproblemer i befolkningen og hvilken betydning arbeidsforhold har for helse. Mer spesifikt var målet å: (1) undersøke forekomst (prevalens) og fordeling av selvrapporterte, arbeidsrelaterte helseproblemer og deres betydning for nedsatt helse blant 30-, 40- og 45-åringer i Oslo; (2) undersøke sosioøkonomiske ulikheter i forekomst av selvrapporterte korsryggsmerter, nakke-/skuldersmerter og armsmerter blant yrkesaktive i Oslo, samt hvilken betydningen faktorer i arbeidet har for disse ulikhetene; og (3) sammenligne selvrapportering av sammenheng med arbeid for nakke-/skuldersmerter og armsmerter med ekspertvurdering basert på spesifikke kriterier.

Studiepopulasjon og metoder

Denne studien inngikk i Helseundersøkelsen i Oslo 2000–2001 (HUBRO), der alle personer i visse aldersgrupper ble inviterte til en omfattende helseundersøkelse. Alle 30-, 40- og 45-åringer som deltok i undersøkelsen, fikk spørsmål om de hadde hatt ett eller flere av i alt elleve vanlige helseproblemer i løpet av den siste måneden, og om de mente at disse helt eller delvis skyldtes arbeid. Av de 26 074 inviterte i de tre aldersgruppene, var det 8 594 (33 %) som svarte på spørreskjemaet, og artikkel I omfatter disse.

Alle sysselsatte personer som deltok i HUBRO og som svarte på spørsmålene om fysiske jobbkrav, selvbestemmelse i arbeidet og muskel-skjelettsmerter, inngikk i artikkel II (N = 7 293). Yrkesklasse ble brukt som indikator på sosioøkonomisk posisjon. De lavere yrkesklassene ble sammenlignet med den høyeste (overordnet stilling eller selvstendig

akademisk erverv), og man beregnet prevalens (forekomst), prevalensratioer (PR), prevalensdifferanser (PD) og tilskrivbare andeler i befolkningen (population attributable fractions, PAF).

Et utvalg på 217 sysselsatte deltakere i HUBRO, som rapporterte nakke-/skuldersmerter eller armsmerter den siste måneden, ble undersøkt ved Statens arbeidsmiljøinstitutt og inngikk i artikkel III. Et kriteriedokument for vurdering av arbeidsrelasjon (sammenheng med arbeid) for muskel-skjelettsmerter i nakke/skulder/arm ble brukt for å stille diagnose og vurdere smertenes sammenheng med personens nåværende arbeid. Graden av samsvar mellom deltakerne og legene som undersøkte dem (ekspertene), på om smertene var arbeidsrelaterte ble målt som "observert samsvar", positivt og negativt samsvar og kappa (samsvar justert for tilfeldig variasjon).

Resultater

I studien fant man at selvrapporterte, arbeidsrelaterte helseproblemer var svært vanlige. Nesten 60 % rapporterte ett eller flere arbeidsrelaterte helseproblemer, og en stor andel av de helseproblemer som ble rapportert, ble tilskrevet arbeidsforhold, spesielt muskel-skjelettsmerter og uvanlig tretthet/matthet. Det var små aldersforskjeller, men tydelige kjønnsforskjeller i denne populasjonen, med høyere forekomst blant kvinner for mange av helseproblemene.

Blant de 7 293 sysselsatte personene var det klare, sosioøkonomiske gradienter i muskel-skjelettsmerter. Forskjellene var større blant menn enn blant kvinner og større for korsryggsmerter enn for nakke-/skuldersmerter og armsmerter i absolutte mål (PD). Faktorer i arbeidet forklarte ⅓ – ½ av forskjellene i forekomst av korsryggsmerter (begge kjønn) og nakke-/skuldersmerter (menn) mellom den høyeste yrkesklassen og de to laveste (faglærte og ufaglærte arbeidere). Fysiske jobbkrav hadde størst betydning for sosiale ulikheter i korsryggsmerter, mens selvbestemmelse i arbeidet var viktigst for ulikheter nakke-/skuldersmerter og armsmerter. PAF-estimater bekreftet betydningen av disse arbeidsforholdene for sosiale ulikheter i muskel-skjelettsmerter på befolkningsnivå, spesielt for korsryggsmerter.

I studien blant 217 personer som rapporterte nakke-/skuldersmerter eller armsmerter den siste måneden, ble smertene i noe større grad vurdert å ha sammenheng med arbeid av

personene selv enn av legene. Det var likevel ganske stor uenighet om hvilke tilfeller som var arbeidsrelatert. Det var større enighet med hensyn til armsmerter enn nakke-/skulder-smerter, og generelt større enighet om de arbeidsrelaterte enn de ikke-arbeidsrelaterte smertene, særlig blant menn. Graden av samsvar vil være avhengig av hvilke kriterier som legges til grunn, både kriterier for hvilke tilstander som inkluderes og kriterier for vurdering av arbeidsrelasjon, både av personene selv og av ekspertene.

Konklusjon

Den høye forekomsten av selvrapporterte arbeidsrelaterte helseproblemer antyder at det kan være et stort potensial for forebygging av vanlige helseproblemer i befolkningen ved å endre kjente risikofaktorer på arbeidsplassen. Hvis det er årsakssammenheng mellom de undersøkte faktorene i arbeid og muskel-skjelettsmertene, indikerer resultatene at intervensjoner for å redusere tungt fysisk arbeid og tunge løft, samt øke selvbestemmelse i arbeidet, vil kunne redusere sosiale ulikheter i forekomst av muskel-skjelettsmerter. Selvrapportering så ikke ut til å overdrive sammenhengen mellom arbeid og smerter. Dermed vil selvrapporterte data i befolkningsstudier kunne brukes med noe større frimodighet, ikke bare for å følge utviklingen i befolkningen, men også som et grovt mål på arbeidsrelatert sykdom i befolkningen, i alle fall for smerter i nakke/skulder og arm.

4 List of publications

Paper I Mehlum IS, Kjuus H, Veiersted KB, Wergeland E. Self-reported work-related health problems from the Oslo Health Study.
Occup Med (Lond) 2006; 56: 371–379.

Paper II Mehlum IS, Kristensen P, Kjuus H, Wergeland E. Are occupational factors important determinants of socio-economic inequalities in musculoskeletal pain?
Scand J Work Environ Health 2008; 34(4): 250–259.

Paper III Mehlum IS, Veiersted KB, Wærsted M, Wergeland E, Kjuus H. Self-reported versus expert-assessed work-relatedness of pain in the neck, shoulder, and arm.
Scand J Work Environ Health 2009; 35(3): 222-232.

5 Abbreviations and definitions

EGP	Erikson–Goldthorpe–Portocarero (class) schema
HSE	Health & Safety Executive (UK)
HUBRO	The Oslo Health Study (In Norwegian: **H**else**U**ndersøkelsen i **B**ydeler og **R**egioner i **O**slo)
ILO	International Labour Organization
JEM	Job exposure matrix
MSD	Musculoskeletal disorders
NIOH	Norwegian Institute of Occupational Health
NLWO	Norwegian Labour and Welfare Administration (the social security agency, previously called the National Insurance Service)
OR	Odds ratio
OSHA	Occupational Safety and Health Administration (USA)
PAF	Population attributable fraction
PD	Prevalence difference
PR	Prevalence ratio
SEP	Socio-economic position
WHO	World Health Organization

Employed is defined as persons with income from work (Statistics Norway), which includes both employees and self-employed, and is used synonymously with “economically active” and “working population” in this thesis

Socio-economic inequalities is used synonymously with “social inequalities” and “social differences” in this thesis

6 Introduction

The link between occupational hazards and specific diseases were systematically outlined in more than 50 occupations by Ramazzini already some 300 years ago (1). The relationship between certain working conditions and specific health problems is now well established (2-5). However, less is known about the occurrence and distribution of work-related health problems in the general population, in Norway, as well as in most countries (6-8), although some industries have more extensive data, e.g., the off-shore industry (9). Consequently, knowledge is lacking about the impact of working conditions on the *burden of ill-health* and on *health inequalities* between genders and between socio-economic groups. Thus, the potential for prevention of such health problems and reduction of *health inequalities*, by interventions at the worksite, is also not known.

Insufficient sources of information may be one reason for this lack of knowledge. In addition, the use of different definitions or concepts of "work-relatedness" may contribute to this situation.

6.1.1 Sources of information

Information on the impact of working conditions on population health may be obtained from several sources.

6.1.2 Epidemiologic literature

Risk ratios from the epidemiologic literature, combined with exposure prevalences, have been used to calculate the number or the proportion of cases attributable to work for specific diseases, for example cardiovascular diseases (10), shoulder/neck conditions (11), Raynaud's phenomenon (12), hearing difficulties (13), and cause specific mortality (14).

Disease specific attributable proportions are not easily converted into total burden of work-related ill-health. However, in Finland the proportion of all fatalities related to occupational factors has been estimated, based on cause-of-death attributable fractions in the most relevant disease categories (14).

Standardised incidence ratios (SIR) of cancer by occupational group have been calculated to indicate excess risk of cancer or specific types of cancer related to work (15). Similarly, differences in standardised mortality ratios (SMR) and in disability pensioning rates according to occupation or industry may reflect differences in working conditions (9;16-18). However, such studies are only indicative, as “occupation” and “industry” are crude proxy variables for occupational exposures.

Thus, although epidemiologic literature is important in establishing the relationship between working conditions and health, the contribution to the knowledge of the impact of working conditions on *population health* may be more limited.

6.1.3 National registers

National registers of work-related diseases and injuries are other sources for determining the health impact of occupational exposure (19-23). However, the Norwegian registers are far from complete (19;24-26). Although notification is required by law, only 3 % of Norwegian general practitioners and 36 % of occupational physicians reported work-related diseases to the Labour Inspection Authority in 2006 (19), similar to other physician reporting systems (22).

The majority of pleural mesothelioma cases are estimated to be work-related (27;28). Nevertheless, only approximately one third of the cases registered by the Cancer Registry of Norway in the early nineties, were notified to the Labour Inspection Authority (24;28). The proportion that had possibly received compensation for an occupational disease was probably even lower (24;29). Since 1998 the Cancer Registry has reported possible cases of occupational cancer, among them all mesotheliomas, to the Norwegian Labour and Welfare Administration (NLWA – the social security agency), which inform the persons that their cancer might be occupational and they may be entitled to compensation (30;31).
As a consequence, the proportion of mesotheliomas recognised for occupational disease compensation has increased. In the years 2004–2006, 186 mesothelioma cases were registered by the Cancer Registry, while the NLWO recognised 123 cases (66 %) for occupational disease compensation (32).

The association between occupational exposures to asbestos and mesotheliomas is well-known. Nevertheless, the under-reporting of such cases were considerable before the Cancer Registry started their new reporting practice. Under-reporting of diseases where the association with occupation is less certain, is probably much larger (24).

The number of employed people in Finland and Norway is very similar, approximately 2.4 million people aged 17–74 years in 2006 (33;34), although the Finnish population was somewhat larger, 5.3 versus 4.6 million people (35;36). One would expect the number of reported work-related diseases also to be similar in these two Nordic countries; however, that is not the case. While 6 715 recognised or suspected cases of occupational diseases were registered by the Finnish Institute of Occupational Health in 2006 (whereof 1 729 cases of noise-induced hearing loss, 26 %)(37), the number of work-related diseases reported to the Norwegian Labour Inspection Authority was 3 392 (whereof 1 987 diseases of the ear, predominantly noise-induced hearing loss, 59 %)(19). The number of registered diseases of the respiratory system was 1 756 in Finland and only 398 in Norway. Compared with Finland, and disregarding noise-induced hearing loss, the under-reporting of work-related diseases in Norway would be approximately 75 %, and even higher for some diagnoses.

Under-reporting of work-related health problems seems to be a common problem (23;38-42). In a survey covering 14 European countries (not including Norway), only Finland and Luxembourg replied that under-reporting of occupational diseases was not considered a cause for concern in their country (38). In Denmark, under-reporting of cancers with well-known associations with occupational exposures to asbestos (pleural mesotheliomas) and wood dust (sinonasal adenocarcinomas) has been estimated to be around 50 % (39;40), similar to the situation in Norway with respect to mesotheliomas. Considerable under-reporting of work-related health problems has also been shown in the United States, when comparing self-reported data or interview data, including physical examination, with official reporting systems, such as workers' compensation, the mandatory OSHA 200 log, or plant medical records (23;41;42).

Reasons for under-reporting may include:

- Employees believe their health problems are ordinary consequences of their job or of ageing, or that their symptoms are not serious enough (23;38;41).
- Employees fear reprisals, e.g., losing their (usual) job or their income level (23;38;41;43).
- Corporate or government safety incentives stimulate under-reporting (23;41).
- Physicians fail to diagnose or assess the work-relatedness of health problems, or they do not prioritise reporting due to high total workload or few incentives (23;38;39).
- Lack of knowledge about reporting requirements among employees, employers, and physicians (23;29;38;41).

These factors have not been systematically examined in Norway, but, based on experience, they may be important here, as well (29;44).

Work-relatedness is normally easier to assess for injuries than for diseases, since there is no latency. However, in Norway the under-reporting of occupational injuries is also considerable. Gravseth et al. (25) found that only 9 % of serious injuries treated by Oslo Emergency Ward and Oslo Ambulance Service were reported by the employer directly to the Labour Inspection Authority, in accordance with the legal requirement. They estimated that no more than 20–25 % of occupational injuries were reported to the National Insurance Service (now NLWA).

Even for fatal occupational injuries, under-reporting is considerable. Wergeland et al. (45) compared deaths registered by the Labour Inspection Authority with fatal occupational injuries in the Norwegian Cause of Death Registry. They estimated that the real number of fatal injuries for the period 2000–03 was 246, but only 171 deaths (70 %) were registered by the Labour Inspection Authority.

Thus, there is serious under-reporting of work-related diseases and injuries to Norwegian national registers, and calculations based on their quantitative data will tend to underestimate the impact of working conditions on population heath.

6.1.4 Population surveys

Population surveys comprise a third source to information on the impact of working conditions on population health (46-52) and may to certain purposes provide more valuable and timely information on occupational risks than register data (41). Work-related illness based on the perceptions of individuals is of public concern and may provide more information on work-related illness where work is only a contributing factor, than other reporting systems, such as compensation systems and employer and physician reporting systems.

Statistics Norway runs regular surveys on perceived work exposure and work-related health problems in representative samples of the Norwegian population (46-48). Similar surveys are being conducted in other countries, both national surveys (49-51) and international, within the European Union (52;53). The Norwegian samples used to be too small to give reliable information about work-related health problems in subgroups of the population (54). After the establishment of a National Surveillance System for Work Environment and Occupational Health at the Norwegian Institute of Occupational Health (NIOH) in 2006, the sample size was increased considerably, from a net sample of approximately 2 500 to 10 000 employed people. Thus, working conditions and work-related health problems can now be displayed for many occupational groups (55).

Population surveys are based on self-reported data. The concept of work-relatedness among lay people may not be the same as used by professionals (49;56); however, this has rarely been studied. Although self-reported data is often used to follow population trends in work-related illness, the use of such data as a measure of work-related illness in the population has often been considered with scepticism, assuming this would give exaggerated estimates.

6.2 The concept of work-relatedness

The definition of work-relatedness may differ in different locations and settings, according to context and purpose (57;58). The definition may also vary over time (58).

6.2.1 Work-relatedness in a preventive context

If the aim is prevention of work-related illness, a wide definition may be preferable in order to prevent as much illness as possible (59;60). The World Health Organization (WHO) defines work-related diseases as multifactorial “disorders to which the work environment and performance of work contribute significantly as one of several causative factors” (2;57). In an annex to a recent regulation in the European Union (61), work-related health problems and illnesses are defined as “those health problems and illnesses which can be caused, worsened or jointly caused by working conditions”, and explicitly include both physical and psychosocial health problems. According to the American Occupational Safety and Health Administration (OSHA)(62), an injury or illness must be considered “work-related if an event or exposure in the work environment either caused or contributed to the resulting condition or significantly aggravated a pre-existing injury or illness”.

In regular surveys of work-related health problems conducted by Statistic Norway (46-48), the following question has been used: “Is this [health problem] totally or partially caused by your present job?” In the similar British surveys of work-related illness, the Health & Safety Executive (HSE)(49) has used the question: "Was your [complaint] caused by your work, or did your work simply make it worse?" The HSE comments on this question, as follows: “In strict logic, three patterns of work/illness relationship can be defined: *causation* (the illness would not have occurred without the work effect); *contributory causation* (work is one of several factors directly affecting the disease process: absence of the work effect could influence the onset and course of the illness, but not remove the disease altogether); and *symptom exacerbation* (the effect of the illness is made worse by work, but work does not contribute to the underlying disease process)“ (49).

Thus, in preventive settings, these three concepts are commonly included in the definition of work-relatedness:

- caused by working conditions (causation)
- jointly caused by working conditions (contributory causation)
- worsened or aggravated by working conditions (symptom exacerbation)

All three of them are important for the occurrence and/or seriousness of illness in the population, and are therefore logical targets for preventive efforts.

6.2.2 Work-relatedness in a compensatory context

In a compensatory context, work-related injury and disease is usually defined by law; thus the concept of work-relatedness is a legal concept in this context (58;63). In the English-speaking world, the expression "arising out of and in the course of employment" is commonly used to define work-relatedness. In a few American states and in Australia this expression has been changed to "arising out of *or* in the course of employment" (58).

"Arising out of employment" expresses a causal relationship between the injury or disease and the employment, whereas "in the course of employment" expresses work-relatedness in terms of a nexus of time, place and activity (58). The Norwegian Act relating to industrial injury insurance expresses the nexus of time, place and activity as follows: "injuries and diseases incurred by employees at work, at their place of work, during working hours" (64).

The definition of work-relatedness, in the sense of a causal relationship, is commonly narrower when used in a compensatory, compared to a preventive context (60;65). Many countries have established national lists or schedules of occupational diseases eligible for compensation, for which a causal relationship has been established (66;67). To be included in the British scheduled list of prescribed (occupational) diseases, a disease must "more likely than not" be caused by work, defined as an attributable fraction greater than 50 %, or a (more than) doubling of risk for a person in a particular job compared to someone not in that occupation (60;65). In Finland, there are similar requirements for a disease to be considered occupational: "Occupational diseases are illnesses primarily caused by a physical, chemical or biological factor at the workplace, their attributable fraction is more than 50 %" (63). However, diseases caused by other factors "are also compensated as occupational diseases, if it can be proven that they were probably caused by the factors in question". In other countries, requirements are seemingly less strict, or less strictly defined. In Denmark, occupational diseases are "diseases which, according to medical documentation, are brought about by specific influence to which certain groups of people, through their work or working conditions, are more exposed than persons not having such work"(68;69). The Danish Parliament passed a reform in 2003 with the aim, among other things, to accept approximately 1000 more occupational disease claims per year, representing an increase of 40 % (70). As a consequence, the Danish criteria for a disease to be included in their list of

occupational diseases was made less strict (68;69). This illustrates that the legal concept of work-relatedness is not only a medico-legal, but also a political issue.

Often the causal relationship between exposure and disease is established in two steps. In Finland, this is explicitly stated (71): First, a causal relationship is known to exist between exposure and disease (based on epidemiologic literature). Second, the diagnosis is confirmed and a causal relationship is likely to exist for the *individual* in question (etiognosis). For diseases on the list of occupational diseases, the first step is already established. The British compensation scheme also requires that "the attribution of *particular* cases to the nature of employment can be established or presumed with reasonable certainty" (65).

However, an assessment of the contribution of work in individual cases is not always found to be necessary. A certain presumption of an occupational origin for diseases on the national list is common, varying from indicative to irrebuttable in different countries (66;67). In France, "any disease which meets the medical, occupational and administrative criteria given in the lists is systematically presumed to be occupational in origin, without it having to be proven" (72).

International lists of occupational diseases have also been established, e.g., by the International Labour Organisation (ILO) (73-75) and the European Union (76). The ILO conventions (73;74) are mandatory for the member states once they are ratified, while both the ILO recommendation (75) and the European schedule of occupational diseases (76) have status as recommendations and have wider aims, which also include recording and prevention of occupational diseases.

6.2.3 Lay versus professional concept of work-relatedness

The concept of work-relatedness may differ between groups of people, e.g., between the general population and physicians (49;56), or between different professions (77). Perceived disease causation may also vary between people of different countries and cultures (78). Only few studies have compared self-assessment and physician-assessment of work-relatedness. Plomp (56) found hardly any relationship between Dutch occupational physicians' and employees' judgment on the work-relatedness of health problems presented during a consultation hour. The British HSE (49) found that the treating doctors (usually the

general practitioner) largely supported their patients' assessment of work-relatedness in a survey on self-reported work-related illness. Only cases reported as work-related were studied, and in 80 % of the cases in which the doctor gave an opinion, work was considered possibly, probably or definitely a cause of the illness. The results of the two studies are thus highly divergent.

6.2.4 Impact of working conditions on population health

As stated, there is a lack of knowledge about the occurrence and distribution of work-related health problems in the Norwegian general population. The available data sources are generally established for other purposes than to provide knowledge of work-related ill-health (23). Sources that are the more reliable as to information of work-relatedness, e.g., registers of work-related or occupational diseases, are usually less reliable as to completeness, and vice versa; the more reliable sources as to completeness or representativeness, e.g., population surveys, might be less reliable as to their information of work-relatedness, but this is not known.

6.3 Socio-economic inequalities in health

6.3.1 Explanations to socio-economic inequalities in health

Socio-economic inequalities in health are well documented, and several hypotheses have been suggested (79). The causal direction is a central issue. Does low social position lead to poor health (social causation), or does poor health lead to low social position (health selection)?

Health-related selection or mobility seems to be less important in explaining social inequalities in health than social causation (80;81). With respect to the latter, some state that *materialistic* factors (housing, employment, environment, including work, etc.) are the most important, and have a direct effect on health. Others argue that materialistic factors, in addition, have indirect effects via *psychosocial* mechanisms. Others again, claim that the direct effect of psychosocial factors, as such, is the most important in Western countries. In addition to these structural explanations, there is the *individualistic* model, emphasising individual lifestyle, such as diet, substance use, and physical activity (79).

These explanations are not incompatible. Since health outcomes may have different causal mechanisms, they may also differ in explanations or combinations of explanations to social inequalities in health. Musculoskeletal disorders (MSD), e.g., may be caused by both physical and psychosocial factors, which often are socially distributed, and thus, social inequalities in MSD may have both materialistic and psychosocial explanations.

6.3.2 Impact of working conditions on socio-economic inequalities in health

The impact of working conditions on socio-economic inequalities has been studied for various health outcomes, e.g., mortality (82), coronary heart disease (83), self-rated general health (84-89), and mental health (89). A few studies have examined the impact of working conditions on socio-economic inequalities in MSD, measured as physician-diagnosed disorders (90), self-reported disorders diagnosed by a physician (91), sickness absence (92;93), or disability pensioning (94). Aittomäki et al. (91) showed that the occupational class-gradient in MSD was largely explained by physical demands at work. Melchior et al. (90) found that physical work factors accounted for over 50 % of the differences between manual workers and other workers in physician-diagnosed upper-limb disorders, higher for some diagnoses. Melchior et al. (92) also reported that working conditions explained approximately 25 % of the occupational class-gradients in musculoskeletal-related sickness absence. Hagen et al. (94) found that the inverse association between education and occupational disability from back pain was partly mediated through working conditions. However, data on the impact of different occupational factors on socio-economic inequalities in musculoskeletal pain in specific body regions have rarely been reported.

The impact of *psychosocial working conditions* on social inequalities in health has been extensively studied and has been documented for a number of outcomes, such as cardiovascular disease, depression, type 2 diabetes, alcohol dependence, MSD, and sick leave (95). The impact of *physical working conditions* on social inequalities in health has been much less studied (80;96). The documentation for a causal relationship between working conditions and health is, however, generally better for physical factors than for psychosocial factors, e.g., with respect to MSD (5;97).

7 Aims

The aims of this thesis were to investigate the occurrence and distribution of work-related health problems in the population and the impact of working conditions on health.

The more specific objectives were to

- examine the prevalence and distribution of self-reported work-related health problems and their impact on the burden of ill-health among Oslo citizens aged 30, 40 and 45 years (Paper I)
- quantify socio-economic inequalities in the occurrence of low back pain, neck/shoulder pain, and arm pain in the general working population in Oslo, and examine the impact of job characteristics on these inequalities (Paper II)
- compare self-reported work-relatedness of neck/shoulder pain and arm pain with experts' assessments based on specific criteria (Paper III)

8 Study populations and methods

8.1 Study populations and questionnaires

This study was part of the Oslo Health Study (HUBRO), a cross-sectional population study, conducted from May 2000 to September 2001 under the joint collaboration of the Norwegian Institute of Public Health, the University of Oslo, and the Municipality of Oslo. All individuals in Oslo County born in 1970, 1960, 1955, 1940/41, and 1924/25 (40 888 in total) were invited by letter to attend a health screening (98). The three youngest cohorts, aged 30, 40, or 45 years at the time of the screening, were selected for the present study.

The flow chart (figure 1) shows the number of subjects in these three age cohorts, invited to the Oslo Health Study (N = 26 074), and included in Papers I, II, and III, respectively.

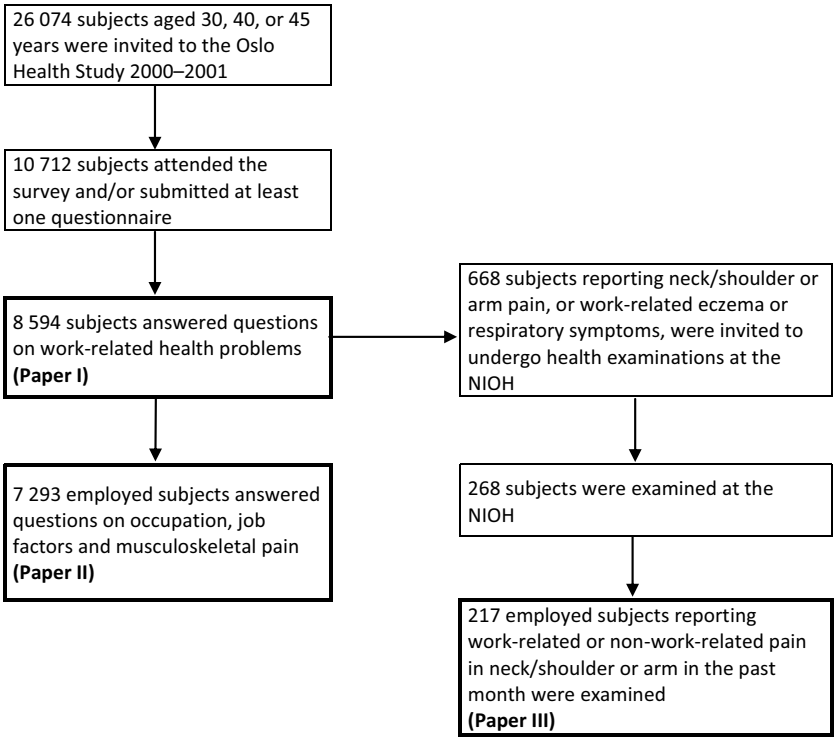


Figure 1. Study populations. Subjects aged 30, 40, or 45 years, invited to the Oslo Health Study, and included in Papers I, II and III, respectively.

In the three age cohorts, 10 712 (41 %) attended a physical examination or completed at least one questionnaire, and 8 594 (33 %) returned an age specific supplementary questionnaire, which included questions on work-related health problems (see Appendix I), similar to questions used by Statistics Norway in regular national surveys (46). The introductory question, "Have you experienced any of the following common health problems in the last month, and are they totally or partially caused by working conditions in your present or previous job?" was followed by a list of eleven commonly work-related health problems:

- eye symptoms with itchiness, soreness, redness or watering eyes
- nose symptoms with stuffiness, sneezing or running nose
- chest tightness, wheezing
- heavy breathing when walking up hills or climbing stairs
- eczema, itching skin, skin rash
- impaired hearing
- pain in neck or shoulders
- pain in elbow, forearm, hand
- low back pain
- extraordinary tiredness or fatigue
- 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".

Paper I comprises the 8 594 responders to the questions on work-related health problems, 4 839 women (56 %) and 3 755 men (table 1). Paper II is restricted to 7 293 of these responders, with data on musculoskeletal pain, occupation, and job characteristics, 4 042 women (55 %) and 3 251 men.

Table 1. Distribution of subjects in Paper I according to gender and age.

Age (years)	Men	Women	All
30	1455	1855	3310
40	1204	1550	2754
45	1096	1434	2530
All	3755	4839	8594

A subpopulation of responders was invited to undergo a health examination at the NIOH: all subjects reporting work-related eczema or respiratory symptoms (N = 508), and 160 of those who reported work-related or non-work-related neck/shoulder pain or arm pain. Of these 668 subjects, 268 were examined between September 2000 and September 2002 by one of three participating physicians in the Department of Occupational Medicine at the NIOH. Paper III comprises 217 employed subjects (employees or self-employed) reporting neck/shoulder pain or arm pain during the month preceding the examination, 142 women (65 %) and 75 men.

8.2 Study outcomes

Paper I Prevalences of eleven self-reported *health problems* and *work-related health problems*, and the corresponding *work-related fractions* (the ratios between the two prevalences).

Paper II Socio-economic differences in the prevalences of low back pain, neck/shoulder pain, and arm pain, the proportion of these differences explained by job factors, and the population attributable fractions (PAF) of these job factors on the social differences in musculoskeletal pain.

Paper III Measures of agreement between self-reported and expert-assessed work-relatedness of neck/shoulder pain and arm pain.

8.3 Socio-demographic variables

8.3.1 Gender and age

Data were analysed according to gender in all three papers, and according to age in Paper I (30 years versus 40/45 years) and Paper III (30 years versus 45 years, not shown in detail). Results were adjusted for age in Paper II.

8.3.2 Country of birth

Country of birth (Norway, Western countries, or non-Western countries) was included in analyses in Paper II. Data were analysed according to country of birth in Paper I; results were not shown in detail; however, they are presented in this thesis (table 3).

8.3.3 Occupational class

In Paper II, the indicator of socio-economic position was based on questions on the participants' longest held occupation in the past 12 months, classified according to the Erikson–Goldthorpe–Portocarero (EGP) schema. Category III (routine non-manual employees) was subdivided into IIIa (higher) and IIIb (lower), as in the full 11-class version of the EGP schema, while category V (lower-grade technicians and supervisors of manual workers) and VI (skilled manual workers) were collapsed, as in the 7-class version of the schema, and called "skilled workers", leaving seven categories in the analyses (figures 2, 3, and 6). The highest occupational class (I) was chosen as reference category.

8.4 Working conditions

In Paper II, physical job demands and job autonomy were included in the analyses. Occupational risk factors known to be specifically associated with pain in the neck/shoulder or arm were essential in the evaluation of work-relatedness in Paper III, both physical and non-physical factors.

8.4.1 Job characteristics included in Paper II

8.4.1.1 Physical job demands

Physical job demands were measured by asking "How would you describe your current work?", followed by four mutually exclusive response categories: "mainly sedentary work", "work involving a lot of walking", "work involving a lot of walking and lifting", and "heavy physical work". Work involving a lot of walking was chosen as reference category. Figure 2 displays the distribution of the two categories with heaviest work ("walking and lifting" and "heavy physical work"), combined, according to occupational class.

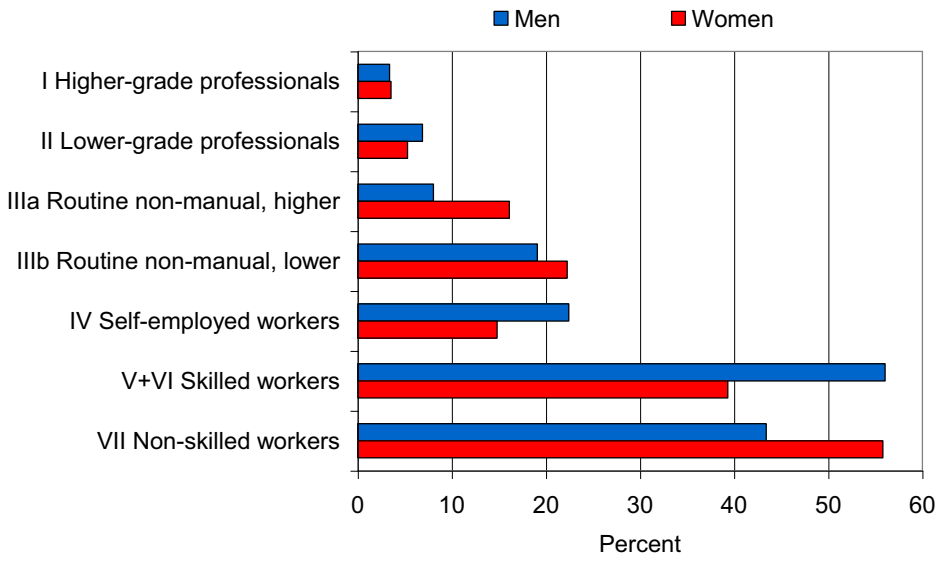


Figure 2. Distribution of "walking and lifting" and "heavy physical work", combined, according to occupational class, among women and men aged 30, 40, and 45 years.

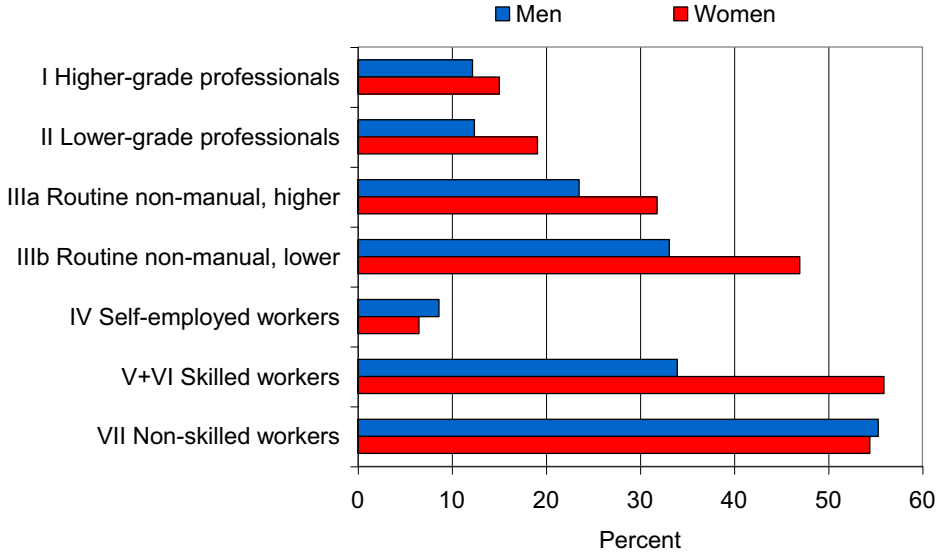


Figure 3. Distribution of the two lowest categories of job autonomy, combined, according to occupational class, among women and men aged 30, 40, and 45 years.

8.4.1.2 Job autonomy

Job autonomy was assessed with the question, "Can you yourself decide how your work should be organised?", with the following response categories: "no, not at all", "to a small degree", "yes, largely", and "yes, I decide myself", ranging from 1 (low) to 4 (high) autonomy in the analyses. The highest category of job autonomy (4) was chosen as reference category. The distribution of the two lowest categories of job autonomy, combined, is presented according to occupational class in figure 3.

8.4.2 Occupational risk factors included in Paper III

The included physical and non-physical work factors were based on the "Criteria document for evaluating the work-relatedness of upper-extremity musculoskeletal disorders" (hereafter referred to as the criteria document)(59). These factors are known to be specifically associated with MSD in the relevant body regions, according to scientific literature or the consensus of expert groups. Physical factors comprise posture, force, movement, and vibration, whereas non-physical factors include work organisational and psychosocial factors, such as work–rest ratio, psychological job demands, and social support at work. Job control was not included in the criteria document, but may also be relevant for upper extremity MSD (99-101), and was thus added. Table 2, somewhat adapted from the criteria document, gives an overview of the included occupational risk factors. For the complete list of risk factors, see Appendix II.

Table 2. Occupational risk factors related to disorders in the different upper extremity body regions, somewhat adapted from Sluiter et al. (59).

	Neck region	Shoulder and upper arm region	Elbow and forearm region	Wrist and hand region
Physical factors				
Posture related to frequency or duration or both	X	X	X	X
Force related to frequency or duration or both			X	X
Repetitive movement related to duration	X	X	X	X
Vibrating hand-tools			X	X
Combination of physical factors		X	X	X
Cold[1]				X
Risk-increasing non-physical factors				
Insufficient recovery time	X	X	X	X
High psychological job demands	X	X	X	X
Low job control	X	X	X	X
Low social support at work	X	X	X	X

[1] Not evaluated in the study.

8.5 Criteria for evaluation of work-relatedness

In Paper III, the criteria document was used to (1) establish clinical diagnoses, and (2) assess the work-relatedness of pain related to the present job.

8.5.1 Criteria for establishing clinical diagnoses

Subjects reporting pain in neck/shoulder or arm in the past month were classified as having a clinical diagnosis if the following criteria were all satisfied:

- *time criteria*: symptoms present at the examination or at least 4 of the past 7 days
- *symptom criteria* for the relevant clinical diagnoses according to the region of pain
- *sign criteria* for relevant provocative tests

8.5.2 Criteria for assessing the work-relatedness of pain

Assessing the work-relatedness of pain was performed in all subjects, whether or not they had a clinical diagnosis, according to the criteria document, and was based on the presence or absence of:

- a *time relationship* between start of the current job and the development of symptoms
- physical and/or non-physical *occupational risk factors* known to be specifically associated with MSD in the relevant body regions, categorised into three risk zones
- *non-occupational risk factors*

The evaluation of these three steps led to the final decision on the *level of work-relatedness,* categorised into “probably work-related”, “possibly work-related”, and “most likely not work-related”.

8.6 Statistical analyses

Analyses were performed using the statistical software SPSS versions 11.5 (Paper I) and 15.0 (Paper III) (www.spss.com), and Stata/SE 9.2 software (Paper II) (www.stata.com). For all analyses a 5 % level of significance was chosen (95 % confidence intervals or a two-tailed P-value of 0.05).

8.6.1 Descriptive statistics

Descriptive statistics are expressed as percentages, excluding missing answers. Where observed proportions were compared, the chi-square test was used.

8.6.2 Attendance and response frequency

To evaluate potential self-selection according to socio-demographic variables, "attendees" and "responders" of the Oslo Health Study were compared with the "invitees" on background variables, including socio-demographic characteristics based on public register data from Statistics Norway (Paper I). The crude and adjusted odds ratios (ORs) for response among the invitees were estimated by logistic regression including all the socio-demographic variables as covariates.

8.6.3 Measures of association

The causal model used in Paper II is presented in figure 4 (96;102). According to this model, the effect of socio-economic position on health is mainly through differential exposure to specific determinants (103), in this case working conditions. Other determinants are not specified in figure 4. The social gradient in musculoskeletal pain was estimated in models with and without job characteristics, and the change in gradient is a measure of the proportion of the gradient explained by these job characteristics (96). According to this model, job characteristics are both an effect of socio-economic position and a determinant for health.

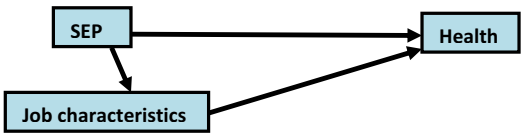


Figure 4. Model for the relationships between socio-economic position (SEP), work, and health. Adapted from Kristensen et al. (96;102).

Associations between occupational class and musculoskeletal pain were estimated both as prevalence ratios and prevalence differences in Paper II, using the BINREG procedure (binomial regression) in Stata. Physical job demands and job autonomy were added separately and together in four multivariate models for each of the three study outcomes of

low back pain, neck/shoulder pain, and arm pain. The percentage of change in the prevalence difference by adding each factor to the model was calculated.

8.6.4 Population attributable fractions

In Paper II, population attributable fractions (PAFs) for occupational class were estimated in the AFLOGIT procedure in Stata, after the inclusion of the determinants in the regression model as dummy variables. The PAF can be interpreted as the proportional reduction in the population prevalence in the hypothetical case that the whole population experiences the prevalence of the reference category.

8.6.5 Measures of agreement

In Paper III, the study participants had two response categories: “work-related” and “not work-related”, while the physicians had three: “probably work-related”, “possibly work-related”, and “most likely not work-related”. Comparisons were made, with the physicians’ “probably work-related” and “possibly work-related” categories combined as “work-related”, as well as with the “possibly work-related” category omitted. The agreement between participants and physicians was measured as *observed agreement* (the portion of cases for which the raters agree) and as *positive* and *negative specific agreement* (the proportion of cases in a category, positive or negative, for which the raters agree), and *kappa* (chance-corrected agreement) was calculated.

9 Summary of papers

9.1 Paper I

Self-reported work-related health problems from the Oslo Health Study

The objective was to examine the prevalence of self-reported work-related health problems among 30-, 40-, and 45-year-old subjects who attended the Oslo Health Study 2000–2001. They were asked if they had experienced any of eleven common health problems in the past month, and whether they considered these to be work-related. Of the 26 074 invited subjects in these age cohorts, 8 594 (33 %) answered the questionnaire.

Approximately 85 % of the subjects had experienced one or more of the health problems listed, and nearly 60 % considered one or more of them as work-related, most commonly pain in the neck/shoulders (45 % in women and 32 % in men) and low back pain (24 % and 22 %, respectively) (figure 5).

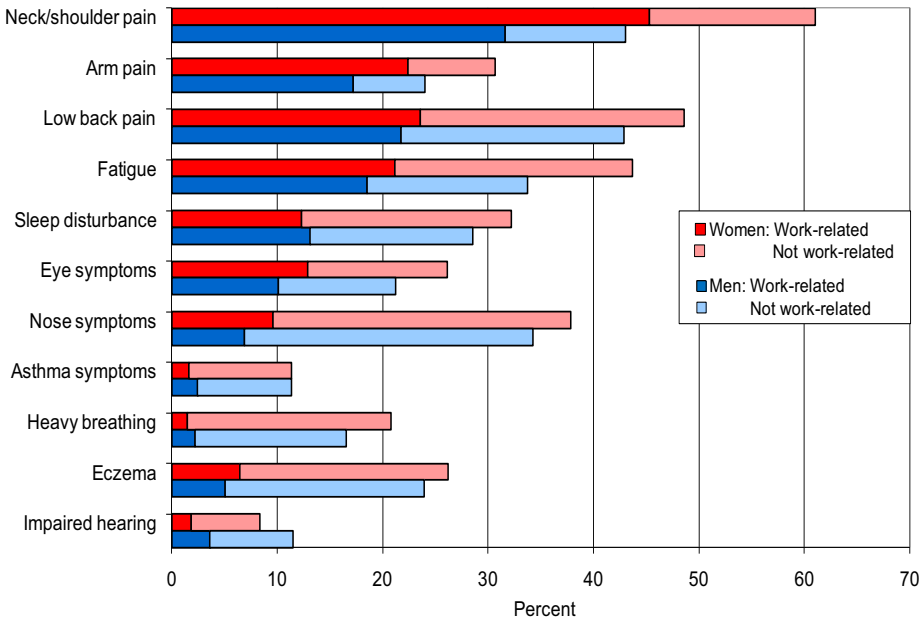


Figure 5. Self-reported work-related and non-work-related health problems experienced in the past month. Prevalences among women and men aged 30, 40, and 45 years. The Oslo Health Study 2000–2001.

Neck/shoulder pain was most frequently attributed to working conditions, by 74% of subjects with this problem; followed by arm pain (72 %), fatigue (51 %), and low back pain (50 %).

There were marked gender differences, but small age differences. Women reported musculoskeletal pain more frequently than men, but the fractions perceived as work-related were the same. Work-related respiratory symptoms and impaired hearing were more prevalent among men and in the oldest age group, and men had higher work-related fractions for asthma symptoms (22 % versus 14 %).

9.2 Paper II

Are occupational factors important determinants of socio-economic inequalities in musculoskeletal pain?

The objective was to quantify socio-economic inequalities in low back pain, neck/shoulder pain and arm pain in the general working population in Oslo, and to examine the impact of job characteristics on these inequalities.

All employed 30-, 40-, and 45-year-old subjects who attended the Oslo Health Study 2000–2001 and answered questions on physical job demands, job autonomy, and musculoskeletal pain were included (N = 7 293). Occupational class was used as an indicator of socio-economic position. The lower occupational classes were compared to higher grade professionals, and prevalences, prevalence ratios (PR), prevalence differences (PD), and population attributable fractions (PAF) were calculated.

There were marked, stepwise socio-economic gradients in musculoskeletal pain, steeper in men than in women (figure 6). The relative differences (PR) were larger for low back pain and arm pain than for neck/shoulder pain. The absolute differences (PD) were largest for low back pain. Physical job demands explained a substantial proportion of absolute occupational class inequalities in low back pain, while job autonomy was more important in explaining inequalities in neck/shoulder pain and arm pain. PAF estimates supported the impact of

these two job characteristics on the social inequalities in musculoskeletal pain in the working population, especially for low back pain.

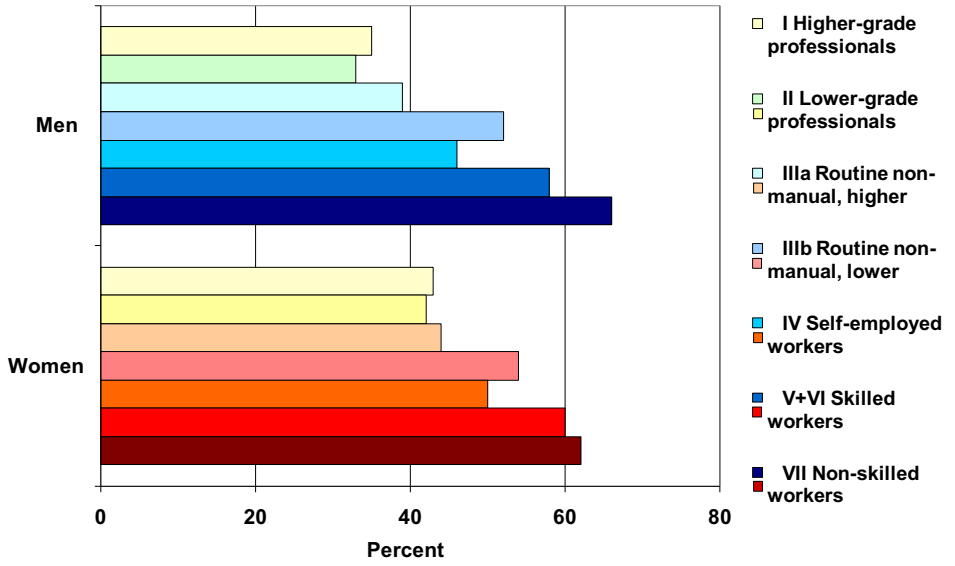


Figure 6. Low back pain experienced the past month, according to occupational class. Prevalence among men and women aged 30, 40, and 45 years. The Oslo Health Study 2000–2001.

9.3 Paper III

Self-reported versus expert-assessed work-relatedness of pain in the neck, shoulder, and arm

The objective was to compare self-reported work-relatedness of neck/shoulder and arm pain with experts' assessments based on specific criteria.

A sample of 217 employed participants in the Oslo Health Study 2000–2001, aged 30, 40, and 45 years, who reported neck/shoulder or arm pain in the past month, underwent a health examination. A criteria document for evaluating the work-relatedness of upper-extremity MSD was used to establish clinical diagnoses and assess the work-relatedness of pain with respect to the subject's present job. Agreement between the participants and

experts on whether pain was related to work was measured as observed agreement, positive and negative specific agreement, and kappa.

Cases were somewhat more frequently assessed as work-related by self-report than by the experts (80 % versus 65 % for neck/shoulder pain, and 78 % versus 72 % for arm pain, respectively). However, there was considerable disagreement as to which cases were work-related. The experts disagreed more frequently in cases that were reported as non-work-related, particularly for neck/shoulder pain and cases reported by men. Positive specific agreement was fairly high (76–85 % in the total population), while negative specific agreement was lower (37–51 %). Kappa values were also low (0.16–0.34).

Compared with expert assessment, self-reporting did not seem to particularly exaggerate work-relatedness. Nevertheless, there was considerable disagreement, especially on cases assessed as non-work-related. However, agreement will depend on the case definitions and the criteria for work-relatedness used both by the participants and the experts.

10 Discussion

10.1 Main results

In the study of 8 594 Oslo citizens, aged 30, 40, and 45 years, self-reported work-related health problems were highly prevalent. Nearly 60 % reported one or more work-related health problem, and a high proportion of reported health problems were attributed to working conditions, especially musculoskeletal pain and fatigue. There were small age differences, but marked gender differences in this population, with higher frequencies among women for many of the health problems.

Among the 7 293 employed subjects, there were marked, stepwise socio-economic gradients in the prevalence of musculoskeletal pain, steeper in men than in women. The relative occupational class differences were larger for low back pain and arm pain than for neck/shoulder pain, and the absolute differences were largest for low back pain. Physical job demands explained a substantial proportion of occupational class inequalities in low back pain, while job autonomy was more important in explaining inequalities in neck/shoulder pain and arm pain. PAF estimates supported the impact of these two job characteristics on the social inequalities in musculoskeletal pain at the working population level, especially for low back pain.

In the comparative study among 217 subjects who reported neck/shoulder pain or arm pain in the past month, cases were somewhat more frequently assessed as work-related by the subjects than by the experts. However, there was considerable disagreement as to which cases were work-related. There was more agreement on arm than neck/shoulder pain and generally more on cases assessed as work-related, as opposed to non-work-related ones, particularly in men.

10.2 Methodological considerations

10.2.1 Strengths of the study

The Oslo health study is a large population-based study, designed to examine socio-economic inequalities in health. All citizens in certain age cohorts were invited, and they represented the full variety of occupations in Oslo and included economically inactive.

10.2.2 Cross-sectional design and health related job change

The cross-sectional design does not allow causal inference between the independent and outcome variables (Paper II). Participants with pain may have a stronger tendency to report heavy work or low job autonomy compared to participants with similar working conditions, but without pain (104), i.e. differential misclassification of exposure. This will probably lead to underestimation of the impact of job factors on social inequalities in health.

Only employed individuals were included in Papers II and III. Health-related job change of participants with health problems, from heavier work in lower occupational classes to lighter work in higher occupational classes (105) or completely out of work (healthy worker effect) (106;107), could also lead to conservative estimates of socio-economic inequalities in health (Paper II).

Health-related job change was documented in Paper III, in which 31 of the 217 subjects with pain in neck/shoulder or arm (14 %) reported they had changed job because of their pain. Work exposure levels below the levels of the Criteria document may lead to the maintenance or recurrence of pain in subjects with work-related pain caused by a previous high-risk job. Such cases might be assessed as work-related by the responder and non-work-related by the expert, according to the criteria, and thus disagreement between responder and physician as to the work-relatedness in the present job.

In Paper I, non-employed individuals were also included. Among the 60 % (N = 5 121) who reported work-related health problems (i.e. caused by present or previous job), 7 % (N = 338) were not employed (8 % in women, 5 % in men), whereas 11 % (N = 583) reported part-time work (17 % in women, 4 % in men) at the time of the examination. Some of these

might be out of work or may have reduced their work participation due to work-related health problems; however, the study has no data on that.

10.2.3 Low attendance

The attendance was higher among females than among males, and increased with age in the Oslo Health Study (Paper I), similar to other population surveys (108-110). Individuals with low education, low income, disability benefit, or of non-Western origin, were under-represented. The low attendance in the Oslo Health Study has been a matter of concern, and possible selection bias has been thoroughly examined. Søgaard et al. (111) evaluated the effect of low attendance in the main survey and concluded that self-selection according to socio-demographic variables had little impact on the prevalence estimates of examined health-related variables (self-rated health, mental health, smoking, and body mass index). As indicated by disability benefit, unhealthy individuals attended to a lesser degree than healthy individuals, particularly among Norwegian men, but social inequality in health by different socio-demographic variables (education, marital status, and residential region) seemed unbiased on a ratio scale (111).

Table 3. Prevalence (%) of self-reported work-related health problems in the past month among Western women (N = 4 418) and men (N = 3 327), and among non-Western women (N = 421) and men (N = 428), aged 30, 40, and 45 years.

	Women		Men	
	Western	Non-Western	Western	Non-Western
Pain in neck or shoulders	44	55	30	48
Low back pain	22	45	19	46
Pain in elbow, forearm, hand	21	40	16	21
Fatigue	20	29	17	30
Sleep disturbance	12	15	12	20
Eye symptoms	13	16	9	18
Nose symptoms	9	15	6	14
Eczema	6	8	4	10
Impaired hearing	2	3	3	7
Chest tightness, wheezing	1	6	1	12
Heavy breathing	1	9	1	10

Those who completed both the main and the supplementary questionnaire, which included the questions on work-related health problems, reported good health more frequently than those who only completed the main questionnaire (Paper I). The response frequency was also lower among individuals born in non-Western countries, a subgroup that reported work-related health problems more frequently than others (table 3). Thus, the response frequency was lower in subgroups with poor health, which is not uncommon (108), and will lead to conservative prevalence estimates for ill-health (Papers I and II). This may also imply conservative estimates of prevalence differences in social inequalities and population attributable fractions, whereas prevalence ratios may be less influenced (Paper II), assuming similar non-participation because of poor health across the occupational classes. Increasing non-participation has been a problem in many epidemiologic studies, especially in recent years, but most empiric work suggests that decline in participation rates are not likely to substantially influence exposure–disease associations (108).

Self-administered questionnaires tend to be returned primarily by those who perceive the questions as relevant to their own situation (108;112). The questions about work-related health problems were only a small part of the supplementary questionnaire. Bias due to selection of individuals with self-perceived work-related health problems is therefore not so likely in Papers I and II. In Paper III, however, the proportion with self-reported work-related pain was somewhat higher in the subpopulation of the study, than in the total study population (the Oslo Health Study). Few subjects reported non-work-related pain, which led to uncertain results in stratified analyses. However, it is not assumed that self-selection of individuals with work-related pain would significantly influence comparisons between self-reported and expert-assessed work-relatedness.

10.2.4 Self-reported data

The data in the study are primarily based on self-report: self-reported health problems (Papers I, II and III), self-reported work exposures (Paper II, and in part Paper III), and self-reported work-relatedness (Papers I and III). Self-reported work-relatedness is, in fact, the main study focus in Paper III.

Subjectivity versus objectivity, who is to define and describe reality, and what is the gold standard or the "truth", are issues of debate (113-116). Some physicians will only use information obtained by methods that require little or no input from the patient or employee, while others find that such information is necessary to get as complete picture as possible (116). The former look at the patients as lay-people with little information to offer with regard to their medical conditions or their workplace exposures, while the latter find that the patients' information on these aspects is essential in the diagnostic process and to understand what factors at work might cause or contribute to their conditions.

10.2.4.1 Self-report of health problems

The data reflect self-reported health problems. People may vary as to what health problems they will report. Bjerkedal & Bakketeig (117) compared patients' reporting of health problems to physicians' reporting based on their health records, and found acceptable agreement, except that some groups of diagnoses tended to be under-reported by the patients, especially mental and musculoskeletal disorders. A hierarchical ordering of the prestige of diseases is found among physicians (118), and may also be present among patients and may lead to under-reporting of low prestige diseases, such as psychiatric diseases and certain musculoskeletal disorders.

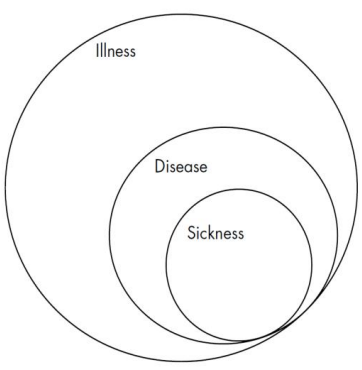
Validation of symptom reporting is often done when validating questionnaires (119-121). In a literature review on asthma and asthma-like symptoms in adults assessed by questionnaires, Torén et al. (119) found that questions about self-reported asthma had a high specificity when validated, both against bronchial challenge tests and a clinical diagnosis of asthma (mean specificity 94 % for both). The sensitivity was lower when validated against bronchial challenge tests (mean value 36 %) than a clinical diagnosis of asthma (mean value 68 %). However, many people with a positive bronchial challenge test report no respiratory symptoms, and thus the use of this test as a gold standard may underestimate the sensitivity of the questionnaire as a diagnostic tool to detect asthma.

Pain is a subjective phenomenon and may not readily be validated, compared to e.g., asthma. However, Björkstén et al. (120) found both sensitivity and specificity to be high (95 % and 88 %, respectively) when questionnaire answers, including visual analogue scale

(VAS) and pain drawings, were compared with a clinical assessment of neck and shoulder pain.

Perrault et al. (121) found only fair to good agreement between the presence of MSD ascertained by self-administered questionnaire and physical examination, and suggested this may reflect differences in the constructs measured. Their questionnaire case definition included specifications as to the duration and intensity of pain (symptoms for ≥ 3 days during the last 7 days, and worst pain intensity > 50 mm on the 100 mm VAS scale), thus only subjects with a certain severity of pain were included. Questionnaire data gave lower prevalences of neck/shoulder pain than those obtained from physical examination. If all subjects reporting pain had been included as questionnaire cases, no matter pain duration or intensity, the results would probably have been the opposite.

The terms “illness”, “disease”, and “sickness” may be used to capture different aspects of ill-health (122;123). Illness may be defined as subjectively experienced ill-health, may include both minor and severe health problems, and is usually self-reported. Disease is a condition that is diagnosed by a physician or other medical expert, while sickness is related to the social role the person with illness or disease takes or is given in society (122;123).



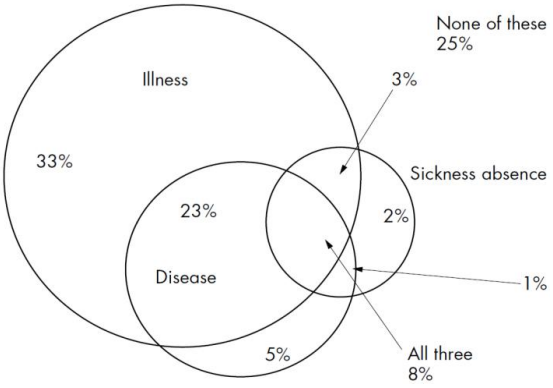


Figure 7a **Figure 7b**

Figure 7a. Hypothetical relation between illness, disease, and sickness absence, respectively.

Figure 7b. Relation between illness, disease, and sickness absence. Percentage of employed aged 16–74 in Sweden 1998–2001 (N = 13 887).

Both figures from Wikman et al. J Epidemiol Community Health 2005.

Wikman et al. (122) compared the relation between these three concepts among 13 887 employed persons aged 16–74 in Sweden 1998–2001, based on interview surveys and registers of sickness absence. They found that most people (67 %) had some sort of illness or complaint. Fewer (38 %) could be registered with a disease, and even fewer (14 %) had more than 14 sick leave days. They had hypothesised the relations displayed in figure 7a, but found that the overlap between the three concepts was fairly low (figure 7b) and very different from the hypothesised relations.

The present study covers mainly subjectively experienced health problems (illness). In Paper III, approximately one in three (37 %), who reported neck/shoulder or arm pain, were found to have clinical diagnoses (disease), and one in four (24 %) had been sick listed during the past year because of their pain (sickness). Since only 268 of the invited 668 subjects participated in the study (40 %), these proportions may not be representative of the invited population or of the Oslo Health Study. However, they illustrate that the reported health problems most likely represent a large variety with respect to severity, and probably also includes minor symptoms.

In cases of claims for financial compensation or legal issues, malingering and exaggeration of symptoms have been an issue (124). On the other hand, the unemployed or people who are afraid of losing their job may understate their symptoms in order to have work. In the case of this study there is no reason to believe that the subjects would exaggerate or understate their symptoms; they had nothing to gain or to lose by reporting their health problems.

10.2.4.2 Self-report of occupational exposure

In Paper II, exposure data were based solely on self-report, and in Paper III, the subjects were an important source of exposure information. The validity of self-reported exposure data has been discussed for different types of occupational exposure, e.g., chemical exposures (113), psychosocial work environment (114), and ergonomic exposures (115;125).

Fritschi et al. (113) argue that while self-respondents have the advantage of having personally experienced the working environments, the experts have significant advantages when it comes to assessing exposure. Experts have a comparative perspective on different occupations and workplaces and can adopt criteria to promote consistency that is impossible with self-reports. They conclude that self-reports of occupational (chemical) exposure are

not sufficiently accurate to warrant their sole use in most population-based studies, but believe that self-reports can be a useful component of a broader exposure assessment strategy. However, they argue that self-report may be more valid than an expert opinion when the expert is unaware of the worker's assessment. But when the expert incorporates the information from self-reports and uses his/her expert judgment to weigh the validity of those self-reports, they believe the expert rating will be closer to the "truth" than the self-report.

According to Theorell & Hasselhorn (114), it is not known to what extent self-reported assessment of the psychosocial working environment reflect individual characteristics, and to what extent they reflect true environmental conditions. More objective (or at least non-subjective) measures have been tested, such as using a psychosocial job exposure matrix, based on population surveys, or expert assessments of work sites, which inevitably will introduce the subjectivity of the expert. They point out that these measures are not only more "objective" than self-reports, they also capture less of the individual's objective working conditions, and conclude that one could not serve as a gold standard for the other.

According to Kuiper et al. (115), self-report of an employee is not accurate enough for an assessment of the level of exposure to the risk factors in their decision model for assessing the work-relatedness of nonspecific low back pain. They recommend the use of objective exposure data, collected by people with relevant education and experience. However, they realise that this is not always possible, and that there is a balance between the required level of accuracy of exposure information on one side, and applicability or feasibility in practice on the other. They conclude that the required level of accuracy for exposure assessment varies and depends on the specific application of the model, and that objective measures of exposure are important, especially in cases of claims for financial compensation or legal issues.

Van der Beek & Frings-Dresen (125) conclude that expert judgements and self reports give only limited insight into the occurrence of tasks and activities. They recommend that further information can be obtained from observations, preferably combined with direct measurements of exposure to posture, movement, and exerted forces, to achieve exposure profiles by occupational task.

However, not all researchers seem to hold the view that self-reported data are inaccurate. Punnett & Wegman (11) state that self-reported ergonomic exposures, in general, appear to be adequate for many epidemiologic purposes.

Job exposure matrices (JEM) have been elaborated for different types of exposure, including ergonomic factors (126). Using JEMs may have several advantages: Less resources is needed for the exposure assessment once the JEM is elaborated, and exposure estimates are assigned consistently, irrespective of the disease status of the subject (126). However, by assigning similar exposures to everyone having the same job title, exposure may be misclassified for a substantial proportion of the subjects. Besides, the evaluation is limited to the occupations and the specific exposures of the JEM.

In the present study, objective exposure data were not available, and virtually impossible to obtain from more than 200 different workplaces in Paper III, not to say the nearly 7 300 workplaces in Paper II. JEMs covering ergonomic and psychosocial factors might have been used in Paper II, but did not seem an obvious and realistic alternative, and might have captured less of the individuals' objective working conditions.

In Paper II, the respondents were assumed to be able to discriminate between the crude categories of the questions on physical job demands and job autonomy. Questions on sitting and standing posture, walking, manual handling, and the general level of physical effort have been found to perform well with respect to reproducibility and validity (127).

In Paper III, exposure assessments did not solely rely on the subjects' self-report of their level of work exposure. Their answers were carefully evaluated by the physicians, who made the final assessment. These physicians were specialists in occupational medicine, worked at the NIOH, had all been working in occupational health services previously, and were thus particularly experienced in evaluating different types of work. According to Fritschi et al. (113), expert opinion with the incorporation of information from self-report is probably a better exposure assessment, than either one alone. Altogether, the evaluation of occupational risk factors was considered to be sufficiently accurate for the study purpose.

10.2.4.3 Common method bias

In Paper II, particularly, self-reported data on both determinants and outcome variables could inflate the results due to common method bias (variance that is attributable to the measurement method rather than to the constructs the measures represent)(128;129), e.g., in relation to personality traits such as negative affectivity. The questions on job characteristics and musculoskeletal pain were separated in different questionnaires, among questions on other topics and had different types of response categories. These factors may reduce common method bias due to self-report tendencies (129).

10.2.4.4 Self-report of work-relatedness

Several factors may influence the attribution of illness to work, for example attitudes and interests, beliefs about disease aetiology, a need to find an external explanation for symptoms, or a potential for economic compensation (56;130-132). The subjects in this study had nothing to gain or to lose by attending the health examination, or reporting their pain as work-related or non-work-related. With the exception of hand-arm vibration syndrome, MSDs are not eligible for compensation in Norway. The participating experts were independent of all stakeholders such as employers, employees/patients or insurance bodies (131), and met the subjects only once in relation to the research project.

10.2.4.5 No blinding of physicians

In Paper III, the physicians were not blind to the subjects' assessments, which is a precondition for the measures of agreement employed. Formalised criteria for work-relatedness were used, and inconsistencies with the criteria were checked for without looking at the subjects' own assessments, both of which may have reduced the interdependence of the two assessments.

10.3 Discussion of results

10.3.1 Occurrence of work-related health problems

In the study of 8 594 Oslo citizens, aged 30, 40, and 45 years, self-reported work-related health problems were highly prevalent (Paper I). Nearly 60 % reported one or more work-related health problem. This result is similar to others. In a study among 2 744 employees in Finland, Räsänen et al. (8) found that 61 % reported that at least one work-related symptom

had occurred during the past two weeks, from a list of 24 symptoms. However, the sample may not have been representative of the Finnish work force. In the Third European Survey on Working Conditions 2000 (53), comprising the 15 members of the European Union at the time (EU 15), 60 % of respondents considered that their work affects their health. The European results are similar to the present study, despite large differences in industries and occupations between the countries, and despite the difference in questioning. The European question, "Does your work affect your health, or not? (IF YES) How does it affect your health?" was followed by a list of 19 health problems, compared to 11 in the Oslo Health Study. However, a change in questioning of the Fourth European Survey in 2005 made the results very different (a prevalence of approximately 30 % in EU 15, 35 % in EU 27) (52), and illustrates that the results may be sensitive to how the questions are posed.

In the present study, the case definitions were based on the self-reported presence of symptoms, and did not include specifications as to their intensity, duration, or physician diagnosis. Different case definitions will often give different prevalences (121). The questions used by Statistics Norway in their regular Surveys of Living Conditions (now called Level of Living Survey), have four response categories, according to degree of suffering (very much / quite a lot / somewhat / not). Statistics Norway usually reports prevalences of the two highest degrees of suffering combined (suffering very much or quite a lot) (46). When comparing the results of the present study with the results of the Survey of Living Conditions 2000, the "suffering somewhat" category was also defined as an affirmative answer. The prevalences in the Oslo Health Study were found to be similar to, or somewhat higher than the corresponding prevalences in the Survey of Living Conditions 2000. These prevalences were considerably higher than the ones usually reported by Statistics Norway, and reflects the difference in case definitions (including/excluding the "suffering somewhat" category).

Pain in neck or shoulders in the past month was the most common health problem and was reported by 61 % of the women and 43 % of the men (Paper I). In a study of primarily female (83 %) users of video display units by Perreault et al. (121), the prevalence of musculoskeletal problems in the neck/shoulder region ranged between 2 % and 42 %, depending on the case definition, which always included specifications as to the severity of pain. This also demonstrates the significance of the case definition.

The *work-related* health problem most frequently reported was also pain in the neck/shoulders (45 % in women and 32 % in men), followed by low back pain (24 and 22 %, respectively), arm pain (22 and 17 %), and fatigue (21 and 18 %). Work-related musculoskeletal pain or fatigue was reported by approximately half of the subjects. Räsänen et al. found that 44 % of the respondents reported work-related musculoskeletal symptoms the past two weeks.

The prevalence of work-related asthma symptoms (chest tightness or wheezing) was 2.1 % (standardised by age and gender). In a random sample of the general population of Hordaland County, Norway (1 275 subjects aged 15–70 years), Bakke et al. (133) found that 0.9 % had ever had work-related asthma, based on positive answers to the questions: “Have you ever had respiratory symptoms in relation to your work?” and “Did the symptoms improve on absence from work?" Thus, the prevalence of the present study was higher than their life time incidence, probably because of their stricter definition of work-related asthma.

10.3.2 Impact of work on ill-health

Work-related fractions were highest for musculoskeletal pain, ranging from 49 to 74 %, and similar in both genders. In the study among employed Finns by Räsänen et al. (8), approximately 70 % of subjects with musculoskeletal symptoms perceived their symptoms as worsened or caused by work. In a representative sample of the Swedish population (25 606 subjects aged 25–75 years), Thorslund et al. (134) found 52 % of women and 66 % of men with long-term musculoskeletal diseases reported these to be due to a particular working condition they had experienced. For skin diseases the proportions were 26 and 15 %, respectively, compared to 25 and 21 %, respectively, in the present study. The proportions among women were lower in the Swedish study, possibly because the pattern of employment may have been different in Sweden some 20 years before the Oslo Health Study. Otherwise these findings are broadly compatible with the results of the present study.

The work-related fraction of asthma symptoms was 18 % (age and gender standardised). An official statement of the American Thoracic Society, based on a review of 21 articles, concluded that 15 % was a reasonable estimate of the occupational contribution to the

population burden of adult asthma (135). Although the methods and populations vary, the results are similar to the present study, and emphasise the importance of work in the causation or exacerbation of asthma.

In a Norwegian study among employed patients in general practice, 40 % of women and 54 % of men reported their current illness to be work-related, highest for MSD, nearly 70 % in both genders (136). In another study, physical workload and psychological factors were assessed to have contributed to 48 and 32 % of sickness certification cases, respectively (137). Physical workload was found to contribute to 78 % of all MSD sickness certification cases, but in > 90 % in patients with heavy physical work. In a third study, more than half of the workers with physician-diagnosed occupational asthma notified to the Norwegian Labour Inspection Authority had left their original jobs at the time of notification (138). Approximately half had experienced a reduction in income 2–6 years later, and had received financial compensation, and the majority was still on anti-asthmatic medication. These studies indicate that work-related health problems often lead to the need for medical help and sick leave, and may also lead to serious chronic disease with socio-economic consequences.

10.3.3 Socio-economic inequalities in musculoskeletal pain

This study demonstrated marked, stepwise socio-economic gradients in musculoskeletal pain, steepest for low back pain, both on a relative and an absolute scale, but also apparent for neck/shoulder pain and arm pain. The outcome measures were crude, with no differentiation between degrees of pain (intensity, frequency, duration, etc.). If the case definition had specified and included only severe pain, the prevalences would have been lower, and the inequalities would probably have been larger. Hagen et al. found stronger association between low socio-economic position and chronic musculoskeletal symptoms (pain and/or stiffness ≥ 3 months during the past year) among subjects with symptoms ≥ 15 days compared to < 15 days during the last 30 days, in a study of 46 901 adults in the Nord-Trøndelag Health Study (HUNT) (139). This was a consistent finding for all nine anatomical locations in the study, including neck, shoulders, low back, elbows and wrist/hands. Low socio-economic class is also found to be associated with higher pain intensity, more

widespread pain, and higher physical disability scores (140) and a less favourable course of pain episodes, with longer duration and/or higher recurrence (141).

In the present study, individuals born in non-Western countries reported work-related health problems more frequently than individuals of Western origin (table 3). They also reported heavy work and low job autonomy more frequently than Western participants: 29 % versus 15 % for the two heaviest categories of physical job demands, and 51 % versus 25 % for the two lowest categories of job autonomy. Claussen et al. (142) recently found four-year risk of disability pensioning in Oslo to be higher among immigrants from developing countries and Eastern Europe as compared to ethnic Norwegians (age- and gender-adjusted OR 2.27). After adjusting for occupation and working conditions, there was no excess risk (OR 0.97), supporting the results of the present study.

10.3.4 Impact of working conditions on socio-economic inequalities in musculoskeletal pain

The impact of working conditions on socio-economic inequalities in musculoskeletal pain has been shown in previous studies (90-94). In the present study, job characteristics explained approximately ⅓ – ½ of the prevalence differences in low back pain (both genders) and neck/shoulder pain (men) between higher grade professionals compared to skilled and non-skilled workers. The proportion explained by each of the job characteristics differed with body region. Physical job demands explained a substantial proportion of occupational class inequalities in low back pain, while job autonomy explained a larger proportion of inequalities in neck/shoulder pain and arm pain.

These results, and the inferences based on them, presume correct measurements, but are also dependent on the causal perspective (96). Paper II was based on a simple causal model (figure 4). However, research on “life course perspective” has focused on the impact of other types of possible causal factors, such as early life exposure and personal attributes (103). This extended perspective requires more complex models, like figure 8, which also includes the simple model in figure 4 (the blue boxes). In the life course perspective, “indirect selection” may be an important explanation to social inequalities in health (103). This mechanism implies that social mobility is selective on determinants of health, not on health itself (103), which means that third variables, that are not involved in direct causal

relationships between socio-economic position and health, are responsible for their covariation (96). Personal attributes, such as cognitive ability, coping styles, personality, and bodily and mental fitness, may be determinants of occupational achievement, as well as later health (96;103). In addition, macro-level conditions (contextual factors, e.g., organisational downsizing) may influence both exposure and health (96).

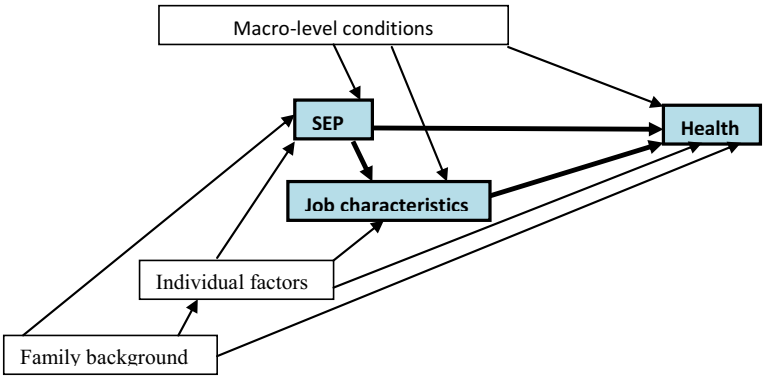


Figure 8. Extended model for the relationships between socio-economic position (SEP), work, and health. Adapted from Kristensen et al. (96;102).

This may imply that the impact of job characteristics (or other determinants) in explaining social inequalities in health could be overestimated in a simple causal model, and that preventive strategies might not be as effective in reducing such inequalities as the results might indicate (96).

10.3.5 Socio-economic position based on occupation

Socio-economic indicators may differ in their ability to discriminate diseases, according to the disease aetiology's relation to stages of the life course (143). Næss et al. found that causes of death known to be related to early-life social circumstances were particularly strongly related to education, and causes of death which were likely to be determined by adult social circumstances were particularly strongly related to occupation and housing conditions, both socio-economic indicators related to adult life (144).

In the present study, not only were exposures (disease aetiology) and socio-economic indicator both related to the adult stage of life, they were also both related to work. An

occupation-based classification system for socio-economic position may be particularly able to capture specific job-related factors (145), and was thus a natural choice in this study. In occupational epidemiology, occupation is sometimes used as a proxy for exposure, and does not merely represent an indicator of socio-economic position, as is often the case in social epidemiology.

The EGP class schema does not have an implicit hierarchical rank (146) and thus, does not necessarily capture a gradient in health across its groups (147). This study showed a pronounced stepwise gradient in both exposures (figures 2 and 3) and musculoskeletal pain (figure 6) (Paper II); however, the heterogeneity of the self-employed group was also apparent (148).

10.3.6 Gender differences

Women reported higher frequencies than men of nearly all the eleven health problems studied and the majority of the work-related health problems. In Norway, the employment level among women is high; in 2000, 82 % of women and 89 % of men in the relevant age groups (25–54 years) were employed (149). Part-time work was more common among women (32 %) than among men (5 %).

Work-related impaired hearing and respiratory symptoms were more frequent in men. This is compatible with men's more frequent exposure to noise and air pollutants at work (52;150). Women reported more frequently pain in the neck/shoulders, arms, and lower back, and also more frequently work-related pain in these regions, in accordance with other studies (8;150-152). Gender differences were larger for neck/shoulder and arm pain than for low back pain, a common finding (153;154).

Different explanations for these gender differences have been suggested, in particular the "exposure hypothesis" and the "vulnerability hypothesis" (154).

10.3.6.1 The exposure hypothesis

Working conditions explain a substantial proportion of MSDs among women workers, as they do among men (153). Hence, gender differences in risk factors at work, as well as at home, may explain the observed prevalence differences (153;154). Men and women often have different jobs (55;155;156). For one thing, women have other occupations than men

(horizontal segregation of the labour market), and more men have superior job positions (vertical segregation), even in many female dominated industries. But even when they have the same occupation, women and men often end up doing different tasks, or doing the same tasks differently, e.g., because of anthropometric differences between the genders and workplace design factors (157;158).

Women, in general, perform more repetitive work and have lower job autonomy (150;153), also within the same occupational classes (figure 3). Repetitive work and low job autonomy are both risk factors for upper extremity MSDs (5;97). Men, on the other hand, have more heavy physical work and lifting, risk factors for low back pain (150;153). Among employed Norwegians, lifting of heavy loads (≥ 20 kg at least five times a day) at work is more common in men, and repetitive work (repeated or monotonous movements most of the time) is somewhat more common in women (150). However, the frequencies of both these ergonomic exposures are reduced with age in men, but not in women.

In addition, women spend more time on household activities than men and have less time for personal recovery and physical exercise, and may thus have a higher total workload in paid and unpaid work (double exposure) (158-160).

The fact that obvious gender differences in exposure do exist, make this a likely explanation of the observed differences in MSD. However, adjustment for occupational exposures in analyses has given inconsistent results (153). Some studies have not been able to show that occupational exposures explain these gender differences (154;155), which suggests there may also be other explanations.

10.3.6.2 The vulnerability hypothesis

Women have smaller bodies, lower muscle strength, and lower aerobic capacity than men. Identical work tasks result in substantially higher muscular activity in relation to capacity, in women compared to men, thus, force-demanding tasks may be considerably more strenuous for females than males (159). Among employed Norwegians, more women (37 %) than men (29 %) feel physically exhausted after work, indicating energy expenditure beyond capacity; the frequency is reduced with age in men, but increased in women (150). Women's lack of reduction in exposure with age, as opposed to men, could, however, also explain this, or there may be a combination of the two explanations.

Gender differences in e.g., muscle fibres and tendons may be of importance (153). The sex hormones, oestrogen and testosterone, may influence pain, and oestrogen like hormones are associated with higher levels of pain (154;161). Gender differences in pain reporting could possibly contribute to the differences in MSD rates, however, studies of this have shown inconsistent results, and some studies have found that men are more likely to report pain without physical findings (153;162). Interaction between exposure and gender has been studied, to examine whether gender modifies the effect of ergonomic exposure on MSD risk, but the results have not been consistent (153;154).

In Paper III, reporting of work-related pain, with which the experts disagreed, was somewhat more frequent in women than in men. Some of the above mentioned explanations may be relevant here, e.g., that force-demanding tasks are more strenuous for females than males (159), and the higher total workload in paid and unpaid work among women (158), both of which may make women more vulnerable to lower levels of physical work exposure.

10.3.7 Age differences

There were only small age differences in the prevalences of work-related health problems between subjects aged 30 years and subjects aged 40 or 45 years (Paper I). Work-related respiratory symptoms, impaired hearing, and arm pain, however, were more frequent in the oldest age group (40/45 years). Respiratory symptoms and impaired hearing may tend to persist after exposure ceases. The higher prevalence of work-related arm pain in the oldest age group, may suggest ongoing exposure or the persistence of pain after reduced exposure.

The prevalence of work-related low back pain was similar in both age groups. Miranda et al. found that work-related factors (physical work load) were more important as predictors of 1-year incidence of low back pain among younger (< 50 years) than among older workers (110). The different outcome measures (prevalence versus incidence), and the relatively young population with a narrow age interval in the present study, could explain the different results. Besides, self-selection or exclusion of older subjects from the most harmful jobs may reduce occurrence of work-related pain in the oldest age group in both studies.

In Paper III, agreement scores for subjects aged 30 years and subjects aged 45 years were compared. Age did not particularly seem to be a consistent predictor of agreement between

participants and experts. In the youngest group, a larger proportion was assessed as work-related by both responder and physician. Very few 30 year-old subjects actually reported non-work-related pain (8 with neck/shoulder pain and only 3 with arm pain), which makes the results more uncertain, particularly on the non-work-related part. Positive specific agreement was similar in both age groups for neck/shoulder pain (77 % and 76 %, respectively) and somewhat higher in the youngest group than in the oldest for arm pain, (92 % versus 80 %, including the possibly work-related cases). On the other hand, negative specific agreement was higher in the oldest group for neck/shoulder pain (48 % versus 20 %) and similar for arm pain (approximately 55 % in both), but based on very few cases reported as non-work-related in the youngest group.

The study shows that work-related health problems are frequent already at the age of 30 years. This is worrisome, as these fairly young individuals ought to have many years in working life until they retire.

10.3.8 Work-relatedness

In this study, the proportion of cases assessed as work-related, as well as the agreement between the participants and the experts, depended on the criteria for work-relatedness used. The discrepancy between the prevalences of work-related pain found in this study compared to the study by a French research group (Roquelaure et al.) (163), employing the same criteria, also indicates that differences in the application of the criteria document may affect the outcome.

According to the criteria document, the occupational risk factor was categorised as unacceptable (red) if at least one physical risk factor was present for the relevant region of pain (59). However, Roquelaure et al. added together the number of risk factors present (both physical and non-physical) for each anatomic region, and classified the level of exposure as acceptable (green), moderate (yellow), or high (red), depending on whether the exposure score was 0, 1, or ≥ 2, respectively (163). Thus, the presence of one physical risk factor would be categorised as “yellow”, according to their procedure, not “red”. If they did follow the criteria document for the rest of their procedure, this would give fewer cases assessed as probably work-related (and more possibly work-related), compared to using the

original procedure. Therefore, their change in procedure cannot explain the higher prevalences.

However, their change is logical in many ways. The presence of more risk factors related to a body region, often increases the risk of disease, in particular certain combinations of risk factors. The risk of carpal tunnel syndrome, e.g., is increased if a combination of two of the following risk factors are present, compared to only one: repetitive movements of the hands, handgrip with high forces, and the use of vibrating tools (164).

According to the criteria document, a physical risk factor is either “unacceptable” (above the risk level with respect to duration per workday) or “acceptable” (not present, or below the risk level). In reality it is not so black-and-white; rather, the longer the duration, the greater the risk, both when it comes to hours per workday and months or years of exposure (cumulative duration), e.g., for shoulder pain (165) and carpal tunnel syndrome (166). Thus, exposure levels below the risk levels of the criteria, may not be risk free at all, especially if combined with other risk factors, or in individuals who are more vulnerable, e.g., because of pre-existing conditions, including work-related pain caused by a previous high risk job, or a high total workload in paid and unpaid work (158). In another study by the French research group (Melchior et al.)(90), physical risk factors were categorised in 3 (not only 2). The presence of risk factors, below the risk level of the criteria document, was assigned a separate category, thus, in part, taking care of the objections.

Knowledge of exposure–response and exposure–effect relationships of occupational risk factors for MSD, alone and in combination with other risk factors, is still limited. Also, the specific definitions of these risk factors may differ between studies, thus making it difficult to define the risk factors precisely. Although using criteria in the assessment of work-relatedness may reduce subjectivity in judgments, it is virtually impossible for a set of criteria to capture all important risk factors. And if it were possible, such a model would probably be too complicated for practical use.

10.4 Generalisability

Only Oslo citizens, aged 30, 40, and 45 years were included in the study. People living in the urban, more multicultural Oslo may differ somewhat from the general population of

Norway. The prevalences of health problems were similar to, or somewhat higher than, the corresponding prevalences in the Survey of Living Conditions 2000 (Paper I). This overall consistency may indicate that the results are fairly representative of the Norwegian population aged 30–45 years.

People outside this range of age may show different results. Most health problems were more prevalent among subjects aged 40/45 years compared to 30 years, but there were less age differences in work-related health problems (Paper I). Statistics Norway includes a representative sample of the population aged 16–66 years in their regular surveys of work-related health problems, commonly presented in 3 age groups (16–24, 25–44, and 45–66 years)(150). Their results for the years 1996, 2000, 2003, and 2006, show that there are minor age differences for most health problems. However, there seem to be marked age gradients for *pain in neck, shoulders or upper back* and *pain in arms, wrists or hands* in both genders (with higher prevalences in women) and for *extraordinary tiredness or fatigue* in women only. This may indicate that for these outcomes the results from the present study may only be valid for the age groups examined.

In Paper III, subjects aged 30 years did not differ systematically from subjects aged 45 years, as to agreement on the work-relatedness of pain, which may indicate that age is not an important predictor of agreement between responders and expert. However, the concept of work-relatedness may differ between different groups of people, e.g., with age, country, or culture. The European Surveys of Working Conditions show large differences between the countries with respect to the impact of work on health (52;53), also between countries that was expected to be rather similar, e.g., the Netherlands and Sweden (25 and 57 %, respectively, reported that work affects their health in the 2005 survey). This may indicate cultural differences between the countries, in addition to actual prevalence differences, with respect to work-related health problems.

11 Conclusions and implications

In this study of subjects aged 30, 40, and 45 years, self-reported work-related health problems were highly prevalent. Nearly 60 % reported one or more work-related health problem, and a high proportion of reported health problems were attributed to working conditions, especially musculoskeletal pain and fatigue. There were small age differences, but marked gender differences in this population, with higher frequencies among women for many of the health problems. Work-related health problems seemed to be frequent already at the age of 30 years, after only few years in working life, which is worrisome.

Among employed subjects in the study, there were marked, socio-economic gradients in musculoskeletal pain, steeper in men than in women. The differences on an absolute scale were largest for low back pain, but were also apparent for neck/shoulder pain and arm pain. Physical job demands explained a substantial proportion of social inequalities in low back pain, while job autonomy was more important in explaining inequalities in neck/shoulder pain and arm pain. PAF estimates supported the impact of these two job characteristics on the social inequalities in musculoskeletal pain in the working population, especially for low back pain.

Among subjects who reported neck/shoulder pain or arm pain in the past month, self-reporting did not seem to particularly exaggerate work-relatedness, compared with expert assessment. However, there was considerable disagreement as to which cases were work-related. There was more agreement on arm than neck/shoulder pain and generally more on cases assessed as work-related, as opposed to non-work-related ones, particularly in men. Agreement will depend on the case definitions and the criteria for work-relatedness used by both participants and experts.

Work-related health problems are in principle preventable. The high prevalences found in this study, suggest a large potential for prevention of common health problems in the population by modification of known risk factors in the workplace. The reported health problems most likely represent a large variety with respect to severity, including minor symptoms. However, prevention in an early stage may prevent chronification of disease; thus, minor work-related symptoms should not be overlooked.

If the associations observed between job characteristics and musculoskeletal pain are causal, the results indicate that interventions to reduce heavy physical work and lifting, and increase job autonomy may reduce social inequalities in the occurrence of musculoskeletal pain. However, since the impact of job characteristics in explaining social inequalities in health could be overestimated in a simple causal model, preventive strategies might not be as effective in reducing such inequalities as the results might indicate.

Self-reporting did not seem to particularly exaggerate work-relatedness. Thus, self-reported data in population surveys may be used more confidently, not only to follow population trends in work-related illness, but also as a rough measure of work-related illness in the population, at least for pain in neck/shoulder or arm. However, the results will depend on the case definitions and the wording of the questions. Since there was disagreement as to which cases were work-related, self-reported work-relatedness may be less accurate in identifying specific cases of work-related illness.

The study displayed large differences in work-related health problems according to country of birth. These should be further studied, especially the impact of job characteristics on the inequalities.

Papers II and III only comprised musculoskeletal pain. Studies of other disease categories may yield different results, and need to be performed.

The discrepancy between the prevalences of work-related pain found in this study compared to the French study indicates differences in the application of the criteria document and the need for further improvement and specification of the criteria.

This study has demonstrated that work may affect health negatively. However, we must not forget that work may also have a positive effect on health, as stated by WHO:

> *"When work is fully adapted to human goals, capacities and limitations, and occupational health hazards are under control, work often plays a role in promoting both physical and mental health" (2)*.

I wish all working people of the world could experience such work!

12 References

(1) Ramazzini B. De morbis artificum [Diseases of workers].Translated from the Latin text of 1713 by Wilmer Cave Wright. New York: Hafner Publishing Company, Inc.; 1964.

(2) World Health Organization. Identification and control of work-related diseases. Report of a WHO Expert Committee. Genève (Switzerland): WHO; 1985. Technical Report Series No. 714.

(3) Torén K, Brisman J, Olin AC, Blanc PD. Asthma on the job: work-related factors in new-onset asthma and in exacerbations of pre-existing asthma. Respir Med 2000;94(6):529-35.

(4) Coggon D. Occupational cancer in the United Kingdom. Environ Health Perspect 1999;107 Suppl 2:239-44.

(5) National Research Council, Institute of Medicine. Musculoskeletal disorders and the workplace: low back and upper extremities. Washington (DC): National Academy Press; 2001.

(6) Coggon D. Monitoring trends in occupational illness. Occup Environ Med 2001;58(11):691-2.

(7) Leigh JP, Markowitz SB, Fahs M, Shin C, Landrigan PJ. Occupational injury and illness in the United States. Estimates of costs, morbidity, and mortality. Arch Intern Med 1997;157(14):1557-68.

(8) Räsänen K, Notkola V, Husman K. Perceived work conditions and work-related symptoms among employed Finns. Soc Sci Med 1997;45(7):1099-110.

(9) Mehlum IS, Kjuus H. Omfang og konsekvenser av arbeidsskader og arbeidsbetinget sykdom på norsk kontinentalsokkel [The Extent and Consequences of Work-Related Injuries and Diseases on Norway's Continental Shelf]. Oslo, Norway: National Institute of Occupational Health; 2005. STAMI-rapport no. 4.

(10) Olsen O, Kristensen TS. Impact of work environment on cardiovascular diseases in Denmark. J Epidemiol Community Health 1991;45(1):4-9.

(11) Punnett L, Wegman DH. Work-related musculoskeletal disorders: the epidemiologic evidence and the debate. J Electromyogr Kinesiol 2004;14(1):13-23.

(12) Palmer KT, Griffin MJ, Syddall H, Pannett B, Cooper C, Coggon D. Prevalence of Raynaud's phenomenon in Great Britain and its relation to hand transmitted vibration: a national postal survey. Occup Environ Med 2000;57(7):448-52.

(13) Palmer KT, Griffin MJ, Syddall HE, Davis A, Pannett B, Coggon D. Occupational exposure to noise and the attributable burden of hearing difficulties in Great Britain. Occup Environ Med 2002;59(9):634-9.

(14) Nurminen M, Karjalainen A. Epidemiologic estimate of the proportion of fatalities related to occupational factors in Finland. Scand J Work Environ Health 2001;27(3):161-213.

(15) Pukkala E, Martinsen JI, Lynge E, Gunnarsdottir HK, Sparén P, Tryggvadottir L et al. Occupation and cancer – follow-up of 15 million people in five Nordic countries. Acta Oncol 2009;48(5):646-790.

(16) Borgan JK. Yrke og dødelighet 1960-2000 [Occupation and mortality 1960-2000]. Oslo: Statistics Norway; 2009. Rapporter 2009/5.

(17) Eriksen T, Mehlum IS. Nye mottakere av uføreytelser i 2005 fordelt på næring, kjønn og alder [New disability pensioners in 2005 according to industry, gender, and age]. Oslo: National Institute of Occupational Health; 2007. NOA-rapport 1/2007.

(18) Bjerkedal T, Wergeland E. Uførepensjonering av kvinner i ulike yrker på grunn av muskel- og skjelettsykdommer [Disability pensions because of musculoskeletal diseases among women of different occupations]. Tidsskr Nor Lægeforen 1995;115(28):3522-7.

(19) Samant Y, Parker D, Wergeland E, Wannag A. The Norwegian Labour Inspectorate's Registry for Work-Related Diseases: Data from 2006. Int J Occup Environ Health 2008;14(4):272-9.

(20) Cherry NM, Meyer JD, Holt DL, Chen Y, McDonald JC. Surveillance of work-related diseases by occupational physicians in the UK: OPRA 1996-1999. Occup Med (Lond) 2000;50(7):496-503.

(21) Cherry NM, McDonald JC. The incidence of work-related disease reported by occupational physicians, 1996-2001. Occup Med (Lond) 2002;52(7):407-11.

(22) Davis L, Wellman H, Punnett L. Surveillance of work-related carpal tunnel syndrome in Massachusetts, 1992-1997: a report from the Massachusetts Sentinel Event Notification System for Occupational Risks (SENSOR). Am J Ind Med 2001;39(1):58-71.

(23) Azaroff LS, Levenstein C, Wegman DH. Occupational injury and illness surveillance: conceptual filters explain underreporting. Am J Public Health 2002;92(9):1421-9.

(24) Wergeland E, Bjerkedal T, Andersen A, Mowé G. Bruk av yrkesskadetrygd ved yrkessykdom [Use of occupational disease benefits]. Tidsskr Nor Lægeforen 1997;117(2):211-6.

(25) Gravseth HM, Wergeland E, Lund J. Underrapportering av arbeidsskader til Arbeidstilsynet [Underreporting of occupational injuries to the Labour Inspection]. Tidsskr Nor Lægeforen 2003;123(15):2057-9.

(26) Nordic Council of Ministers. Anmälda arbetssjukdomar i Norden 1990-1992 [Notified work-related diseases in the Nordic countries 1990-1992]. København: Nordic Council of Ministers; 1996. TemaNord 1996:545.

(27) Tuomi T, Huuskonen MS, Tammilehto L, Vanhala E, Virtamo M. Occupational exposure to asbestos as evaluated from work histories and analysis of lung tissues from patients with mesothelioma. Br J Ind Med 1991;48(1):48-52.

(28) Mowé G, Tellnes G, Andersen A. Malignt pleuralt mesoteliom i Norge 1960-92 [Malignant pleural mesothelioma in Norway 1960-1992]. Tidsskr Nor Lægeforen 1995;115(6):706-9.

(29) Bratt U, Leira HL. Lov om yrkesskadeforsikring - en forbedring for de skadelidte? [The occupational injury act – an improvement for persons with occupational diseases?]. Tidsskr Nor Lægeforen 1997;117(2):207-11.

(30) Kjærheim K, Stender N. Årsrapport 2001 for prosjektet Yrkesbetinget kreft og erstatning [End of the year report 2001 for the project Occupational cancer and compensation]. Oslo: Cancer Registry of Norway and Norwegian Labour and Welfare Administration; 2002.

(31) Klæboe L, Kjærheim K. Yrkesbetinget kreft og erstatning. Et samarbeidsprosjekt mellom Kreftregisteret og Rikstrygdeverket. Kreftregisterets virksomhet 2005. [Occupational cancer and compensation. A collaboration project between the Cancer Registry of Norway and the National Insurance Service] Oslo: Cancer Registry of Norway and Norwegian Labour and Welfare Administration; 2006.

(32) NOU 2008: 11. Yrkessykdommer. Yrkessykdomsutvalgets utredning av hvilke sykdommer som bør kunne godkjennes som yrkessykdom [Occupational diseases. Report from the Occupational Disease Commission on which diseases ought to be recognised as occupational diseases]. Oslo: Government Administration Services; 2008.

(33) Statistics Finland. Labour Force Survey. http://www.stat.fi/til/tyti/2007/04/tyti_2007_04_2007-05-22_tau_002_en.html (Date accessed 11 February 2009).

(34) Statistics Norway. Labour Force Survey, StatBank. http://statbank.ssb.no/statistikkbanken/ (Date accessed 11 February 2009).

(35) Statistics Finland. Population structure. http://www.stat.fi/til/vaerak/2007/vaerak_2007_2008-03-28_tie_001_en.html (Date accessed 11 February 2009).

(36) Statistics Norway. Population structure, StatBank. Oslo: Statistics Norway. http://statbank.ssb.no/statistikkbanken/ (Date accessed 11 February 2009).

(37) Finnish Institute of Occupational Health. Ammattitaudit ja ammattitautiepäilyt 2006. Työperäisten sairauksien rekisteriin kirjatut uudet tapaukset [Recognised or suspected cases of occupational disease in 2006. New cases notified to the Finnish Register of Occupational Diseases]. Helsinki: FIOH; 2008.

(38) Eurogip. Survey of under-reporting of occupational diseases in Europe. Paris: Eurogip (Groupement de l'Institution Prevention de la Securite sociale pour l'Europe); 2002. Report No. Eurogip-03/E.

(39) Skov T, Mikkelsen S, Svane O, Lynge E. Reporting of occupational cancer in Denmark. Scand J Work Environ Health 1990;16(6):401-5.

(40) Danø H, Skov T, Lynge E. Underreporting of occupational cancers in Denmark. Scand J Work Environ Health 1996;22(1):55-7.

(41) Pransky G, Snyder T, Dembe A, Himmelstein J. Under-reporting of work-related disorders in the workplace: a case study and review of the literature. Ergonomics 1999;42(1):171-82.

(42) Silverstein BA, Stetson DS, Keyserling WM, Fine LJ. Work-related musculoskeletal disorders: comparison of data sources for surveillance. Am J Ind Med 1997;31(5): 600-8.

(43) Ameille J, Pairon JC, Bayeux MC, Brochard P, Choudat D, Conso F et al. Consequences of occupational asthma on employment and financial status: a follow-up study. Eur Respir J 1997;10(1):55-8.

(44) Mowé G, Gylseth B. Medico-legal aspects of malignant mesothelioma. Scand J Soc Med 1984;12(1):15-23.

(45) Wergeland E, Gjertsen F, Lund J. Arbeidsskadedødsfall blir underrapportert [Mortality due to occupational injury is underreported]. Tidsskr Nor Lægeforen 2009;129(10):981-6.

(46) Statistics Norway. Survey of Living Conditions 2000. Working environment. http://www.ssb.no/emner/06/02/arbmiljo/arkiv/art-2001-11-27-01.html. (Published 27 November 2001).

(47) Statistics Norway. Survey of Living Conditions 2003. Working environment. http://www.ssb.no/emner/06/02/arbmiljo/arkiv/art-2004-06-23-01.html (Published 23 June 2004).

(48) Statistics Norway. Level of living survey 2006. Work conditions. http://www.ssb.no/english/subjects/06/02/arbmiljo_en/main.html (Published 20 September 2007).

(49) Jones JR, Hodgson JT, Clegg TA, Elliott RC. Self-reported work-related illness in 1995: Results from a household survey. Norwich (UK): Her Majesty's Stationary Office; 1998.

(50) Jones JR, Huxtable CS, Hodgson JT, Price MJ. Self-reported work-related illness in 2001/02: Results from a household survey. Norwich (UK): Her Majesty's Stationary Office; 2003.

(51) Arbetsmiljöverket. Arbetsorsakade besvär 2008 [Work-Related Disorders 2008]. Solna (Sweden): Arbetsmiljöverket; 2008. Arbetsmiljöstatistik Rapport 2008:5.

(52) Parent-Thirion A, Fernández Macías E, Hurley J, Vermeylen G. Fourth European Working Conditions Survey. Dublin (Ireland): European Foundation for the Improvement of Living and Working Conditions; 2007.

(53) Paoli P, Merllié D. Third European Survey on Working Conditions 2000. Dublin (Ireland): European Foundation for the Improvement of Living and Working Conditions; 2001.

(54) Vågane L. Samordnet levekårsundersøkelse 2000 – tverrnsittsundersøkelsen. Dokumentasjonsrapport [Coordinated Survey of Living Conditions 2000 – cross-sectional survey. Documentation report]. Oslo: Statistics Norway; 2001. Report No. 2001/34.

(55) Tynes T, Eiken T, Grimsrud TK, Sterud T, Aasnæss S. Arbeidsmiljø og helse – slik norske yrkesaktive opplever det. Resultater fra Statistisk sentralbyrås levekårsundersøkelse for 2006 [Work environment and health – as experienced by working Norwegians. Results from the Level of living survey 2006 from Statistics Norway. Oslo: National Institute of Occupational Health; 2008. STAMI-rapport 2008 nr. 16.

(56) Plomp HN. Employees' and occupational physicians' different perceptions of the work-relatedness of health problems: a critical point in an effective consultation process. Occup Med (Lond) 1993;43 Suppl 1:S18-S22.

(57) World Health Organization. Epidemiology of work-related diseases and accidents: tenth report of the Joint ILO/WHO Committee on Occupational Health. Genève (Switzerland): WHO; 1989. Technical Report Series No. 777.

(58) Clayton A, Johnstone R, Sceats S. The Legal Concept of Work-Related Injury and Disease in Australian OHS and Workers' Compensation Systems. Australian Journal of Labour Law 2002;15(2):105-53.

(59) Sluiter JK, Rest KM, Frings-Dresen MH. Criteria document for evaluating the work-relatedness of upper-extremity musculoskeletal disorders. Scand J Work Environ Health 2001;27 Suppl 1:1-102.

(60) Chen Y, Agius R, McNamee R, Turner S, Taylor S, Fulluck L et al. Physicians' beliefs in the assessment of work attribution when reporting musculoskeletal disorders. Occup Med (Lond) 2005;55(4):298-307.

(61) Regulation (EC) No 1338/2008 of the European Parliament and of the Council of 16 December 2008 on Community statistics on public health and health and safety at work. Official Journal of the European Union 31.12.2008. L 354/70.

(62) Regulations (Standards - 29 CFR). Recording and Reporting Occupational Injuries and Illnesses. Determination of work-relatedness. - 1904.5. Occupational Safety & Health Administrations.

(63) Finnish Institute of Occupational Health. Occupational diseases. http://www.ttl.fi/Internet/English/Thematic+pages/Occupational+diseases/ (Updated 22 February 2008).

(64) LOV 1989-06-16 nr 65: Lov om yrkesskadeforsikring [Act relating to industrial injury insurance]. http://www.lovdata.no/all/hl-19890616-065.html http://www.ub.uio.no/ujur/ulovdata/lov-19890616-065-eng.pdf

(65) Department for Work and Pensions. Completion of the review of the scheduled list of prescribed diseases. Report by the Industrial Injuries Advisory Council in accordance with Section 171 of the Social Security Administration Act 1992 marking the completion of the review of the scheduled list of prescribed diseases. London: Department for Work and Pensions (DWP); 2007.

(66) Walters D. An International Comparison of Occupational Disease and Injury Compensation Schemes. A Research Report prepared for the Industrial Injuries Advisory Council (IIAC). Cardiff (UK): Cardiff University; 2007.

(67) Eurogip. Occupational diseases in Europe. Comparative survey conducted in 13 countries. Procedures and conditions of declaration, recognition and compensation. Paris: Eurogip (Groupement de l'Institution Prevention de la Securite sociale pour l'Europe); 2000.

(68) Arbejdsskadestyrelsen. The National Board of Industrial Injuries. København [Copenhagen]: The National Board of Industrial Injuries; 2008. http://www.europeanforum.org/pdf/About%20the%20National%20Board%20of%20Industrial%20Injuries.pdf

(69) Arbejdsskadestyrelsen. Vejledning om erhvervssygdomme anmeldt fra 1. januar 2005 [Guide book on occupational diseases reported from 1. January 2005]. København: The National Board of Industrial Injuries; 2007.

(70) Arbejdsskadestyrelsen. Udviklingen på erhvervssygdomsområdet i 2008. Arbejdsskadestyrelsens og Erhvervssygdomsudvalgets årsredegørelse til Folketingets Arbejdsmarkedsudvalg [Trends in occupational diseases in 2008. Yearly report from the National Board of Industrial Injuries and the Occupational Disease Committee to the Danish Parliament, Labour Market Committee]. København: The National Board of Industrial Injuries; 2008.

(71) Finnish Institute of Occupational Health. Yrkessjukdomar [Occupational diseases]. http://www.ttl.fi/Internet/Svenska/Temasidor/Yrkessjukdomar/begrepp.htm (Updated 14 February 2008).

(72) Institut National de Recherche et de Sécurité (INRS). Introduction to occupational diseases. http://en.inrs.fr/ (Topics –> Introduction to occupational diseases) (Updated 22 July 2004).

(73) International Labour Organization. C42 Workmen's Compensation (Occupational Diseases) Convention. Genève (Switzerland): ILO; 1934.

(74) International Labour Organization. C121 Employment Injury Benefits Convention. Genève (Switzerland): ILO; 1964.

(75) International Labour Organization. R194 List of Occupational Diseases Recommendation. Genève (Switzerland): ILO; 2002.

(76) Commission Recommendation of 19 September 2003 concerning the European schedule of occupational diseases (2003/670/EC). Official Journal of the European Union 25.9.2003. L 238/28.

(77) O'Neill E, McNamee R, Agius R, Gittins M, Hussey L, Turner S. The validity and reliability of diagnoses of work-related mental ill-health. Occup Environ Med 2008;65(11):726-31.

(78) Payer L. Medicine & culture. Varieties of treatment in the United States, England, West Germany, and France. New York: Henry Holt and Company; 1996.

(79) van der Wel K, Dahl E. Materialistiske og strukturelle forklaringer på sosiale ulikheter i helse [Materialistic and structural explanations to social inequalities in health]. In: Mæland JG, Elstad JI, Næss Ø, Westin S, editors. Sosial epidemiologi. Sosiale årsaker til sykdom og helsesvikt [Social epidemiology. Social causes to disease and ill-health]. Oslo: Gyldendal Norsk Forlag AS; 2009.

(80) Aittomäki A. Social-class inequalities in ill health – the contribution of physical workload. Thesis. Helsinki: University of Helsinki; 2008. Publications of Public Health M 195:2008.

(81) Dahl E, Elstad JI. Kan helserelatert seleksjon forklare sosial ulikhet i helse? [Can health related selection explain social inequality in health?]. In: Mæland JG, Elstad JI, Næss Ø, Westin S, editors. Sosial epidemiologi. Sosiale årsaker til sykdom og helsesvikt [Social epidemiology. Social causes to disease and ill-health]. Oslo: Gyldendal Norsk Forlag AS; 2009.

(82) Virtanen SV, Notkola V. Socioeconomic inequalities in cardiovascular mortality and the role of work: a register study of Finnish men. Int J Epidemiol 2002;31(3):614-21.

(83) Marmot MG, Bosma H, Hemingway H, Brunner E, Stansfeld S. Contribution of job control and other risk factors to social variations in coronary heart disease incidence. Lancet 1997;350(9073):235-9.

(84) Rahkonen O, Laaksonen M, Martikainen P, Roos E, Lahelma E. Job control, job demands, or social class? The impact of working conditions on the relation between social class and health. J Epidemiol Community Health 2006;60(1):50-4.

(85) Schrijvers CT, van de Mheen HD, Stronks K, Mackenbach JP. Socioeconomic inequalities in health in the working population: the contribution of working conditions. Int J Epidemiol 1998;27(6):1011-8.

(86) Borg V, Kristensen TS. Social class and self-rated health: can the gradient be explained by differences in life style or work environment? Soc Sci Med 2000;51(7):1019-30.

(87) Hemström Ö. Health inequalities by wage income in Sweden: the role of work environment. Soc Sci Med 2005;61(3):637-47.

(88) Molarius A, Berglund K, Eriksson C, Lambe M, Nordström E, Eriksson HG et al. Socioeconomic conditions, lifestyle factors, and self-rated health among men and women in Sweden. Eur J Public Health 2007;17(2):125-33.

(89) Laaksonen M, Rahkonen O, Martikainen P, Lahelma E. Associations of psychosocial working conditions with self-rated general health and mental health among municipal employees. Int Arch Occup Environ Health 2006;79(3):205-12.

(90) Melchior M, Roquelaure Y, Evanoff B, Chastang JF, Ha C, Imbernon E et al. Why are manual workers at high risk of upper limb disorders? The role of physical work factors in a random sample of workers in France (the Pays de la Loire study). Occup Environ Med 2006;63(11):754-61.

(91) Aittomäki A, Lahelma E, Rahkonen O, Leino-Arjas P, Martikainen P. The contribution of musculoskeletal disorders and physical workload to socioeconomic inequalities in health. Eur J Public Health 2006;17(2):145-50.

(92) Melchior M, Krieger N, Kawachi I, Berkman LF, Niedhammer I, Goldberg M. Work factors and occupational class disparities in sickness absence: findings from the GAZEL cohort study. Am J Public Health 2005;95(7):1206-12.

(93) Vahtera J, Virtanen P, Kivimäki M, Pentti J. Workplace as an origin of health inequalities. J Epidemiol Community Health 1999;53(7):399-407.

(94) Hagen KB, Tambs K, Bjerkedal T. What mediates the inverse association between education and occupational disability from back pain? - A prospective cohort study from the Nord-Trøndelag health study in Norway. Soc Sci Med 2006;63(5):1267-75.

(95) Siegrist J, Theorell T. Socio-economic position and health: the role of work and employment. In: Siegrist J, Marmot M, editors. Social inequalities in health. New evidence and policy implications. Oxford (UK): Oxford University Press; 2006.

(96) Kristensen P. Inequalities in health, social causation and the role of occupation. Scand J Work Environ Health 2008;34(4):235-8.

(97) Knardahl S, Veiersted KB, Medbø JI, Matre D, Jensen J, Pedersen LM et al. Arbeid som årsak til muskel-skjelettlidelser: Kunnskapsstatus 2008 [Occupational factors in the pathogenesis of musculoskeletal disorders. State of knowledge 2008.]. Oslo: National Institute of Occupational Health; 2008. STAMI-rapport 2008/22.

(98) Norwegian Institute of Public Health. The Oslo Health Study. http://www.fhi.no/eway/default.aspx?pid=238&trg=MainArea_5811&MainArea_5811=5903:0:15,4563:1:0:0:::0:0 (Updated 23.04.2009).

(99) Palmer KT, Smedley J. Work relatedness of chronic neck pain with physical findings - a systematic review. Scand J Work Environ Health 2007;33(3):165-91.

(100) Ariëns GA, van Mechelen W, Bongers PM, Bouter LM, van der Wal G. Psychosocial risk factors for neck pain: a systematic review. Am J Ind Med 2001;39(2):180-93.

(101) Bongers PM, IJmker S, van den Heuvel S, Blatter BM. Epidemiology of work related neck and upper limb problems: Psychosocial and personal risk factors (Part I) and effective interventions from a bio behavioural perspective (Part II). J Occup Rehabil 2006;16(3):272-95.

(102) Kristensen P, Mehlum IS, Gravseth HM. Arbeid og yrke: Helsefremmende og helseskadelige faktorer [Work and occupation: Health-promoting and health-damaging factors]. In: Mæland JG, Elstad JI, Næss Ø, Westin S, editors. Sosial epidemiologi. Sosiale årsaker til sykdom og helsesvikt [Social epidemiology. Social causes to disease and ill-health].Oslo: Gyldendal Norsk Forlag AS; 2009.

(103) Mackenbach JP. Genetics and health inequalities: hypotheses and controversies. J Epidemiol Community Health 2005;59(4):268-73.

(104) Balogh I, Ørbæk P, Ohlsson K, Nordander C, Unge J, Winkel J et al. Self-assessed and directly measured occupational physical activities – influence of musculoskeletal complaints, age and gender. Appl Ergon 2004;35(1):49-56.

(105) Östlin P. Negative health selection into physically light occupations. J Epidemiol Community Health 1988;42(2):152-6.

(106) Brage S, Bjerkedal T, Bruusgaard D. Occupation-specific morbidity of musculoskeletal disease in Norway. Scand J Soc Med 1997;25(1):50-7.

(107) Punnett L. Adjusting for the healthy worker selection effect in cross-sectional studies. Int J Epidemiol 1996;25(5):1068-76.

(108) Galea S, Tracy M. Participation Rates in Epidemiologic Studies. Ann Epidemiol 2007;17(9):643-53.

(109) Eagan TM, Eide GE, Gulsvik A, Bakke PS. Nonresponse in a community cohort study: predictors and consequences for exposure-disease associations. J Clin Epidemiol 2002;55(8):775-81.

(110) Miranda H, Viikari-Juntura E, Punnett L, Riihimaki H. Occupational loading, health behavior and sleep disturbance as predictors of low-back pain. Scand J Work Environ Health 2008;34(6):411-9.

(111) Søgaard AJ, Selmer R, Bjertness E, Thelle D. The Oslo Health Study: The impact of self-selection in a large, population-based survey. Int J Equity Health 2004;3(1):3.

(112) Dickinson CE, Campion K, Fostyer AF, Newman SJ, O'Rourke AMT, Thomas PG. Questionnaire development: An examination of the Nordic musculoskeletal questionnaire. Appl Ergon 1992;23(3):197-201.

(113) Fritschi L, Siemiatycki J, Richardson L. Self-assessed versus expert-assessed occupational exposures. Am J Epidemiol 1996;144(5):521-7.

(114) Theorell T, Hasselhorn HM. On cross-sectional questionnaire studies of relationships between psychosocial conditions at work and health--are they reliable? Int Arch Occup Environ Health 2005;78(7):517-22.

(115) Kuiper JI, Burdorf A, Frings-Dresen MH, Kuijer PP, Spreeuwers D, Lötters FJ et al. Assessing the work-relatedness of nonspecific low-back pain. Scand J Work Environ Health 2005;31(3):237-43.

(116) Lax MB, Manetti FA, Klein RA. Medical evaluation of work-related illness: evaluations by a treating occupational medicine specialist and by independent medical examiners compared. Int J Occup Environ Health 2004;10(1):1-12.

(117) Bjerkedal T, Bakketeig L. Påliteligheten av intervjuopplysninger om helseforhold [Validity of health interview surveys]. Tidsskr Nor Lægeforen 1975;95(15):927-31.

(118) Album D, Westin S. Do diseases have a prestige hierarchy? A survey among physicians and medical students. Soc Sci Med 2008;66(1):182-8.

(119) Torén K, Brisman J, Järvholm B. Asthma and asthma-like symptoms in adults assessed by questionnaires. A literature review. Chest 1993;104(2):600-8.

(120) Björkstén MG, Boquist B, Talbäck M, Edling C. The validity of reported musculoskeletal problems. A study of questionnaire answers in relation to diagnosed disorders and perception of pain. Appl Ergon 1999;30(4):325-30.

(121) Perreault N, Brisson C, Dionne C, Montreuil S, Punnett L. Agreement between a self-administered questionnaire on musculoskeletal disorders of the neck-shoulder region and a physical examination. BMC Musculoskelet Disord 2008;9(1):34.

(122) Wikman A, Marklund S, Alexanderson K. Illness, disease, and sickness absence: an empirical test of differences between concepts of ill health. J Epidemiol Community Health 2005;59(6):450-4.

(123) Alexanderson K. Measuring health. In: Kilbom Å, Messing K, Bildt Thorbjörnsson C, editors. Women's health at work. Solna (Sweden): National Institute for Working Life; 1998. p. 121-61.

(124) Waddell G, Aylward M, Sawney P. Low back pain, disability and social support. Back pain, incapacity for work and social security benefits: an international literature review and analysis. London: The Royal Society of Medicine Press Limited; 2002. p. 1-71.

(125) van der Beek AJ, Frings-Dresen MH. Assessment of mechanical exposure in ergonomic epidemiology. Occup Environ Med 1998;55(5):291-9.

(126) Kauppinen T, Toikkanen J, Pukkala E. From cross-tabulations to multipurpose exposure information systems: a new job-exposure matrix. Am J Ind Med 1998;33(4):409-17.

(127) Stock SR, Fernandes R, Delisle A, Vezina N. Reproducibility and validity of workers' self-reports of physical work demands. Scand J Work Environ Health 2005;31(6):409-37.

(128) Kristensen P. Bias from nondifferential but dependent misclassification of exposure and outcome. Epidemiology 1992;3(3):210-5.

(129) Podsakoff PM, MacKenzie SB, Lee JY, Podsakoff NP. Common method biases in behavioral research: a critical review of the literature and recommended remedies. J Appl Psychol 2003;88(5):879-903.

(130) Abba K, Clarke S, Cousins R. Assessment of the potential effects of population changes in attitudes, awareness and beliefs on self-reporting of occupational ill-health. Occup Med (Lond) 2004;54(4):238-44.

(131) Dembe AE. Occupation and disease: How social factors affect the conception of work-related disorders. New Haven (CT, USA): Yale University Press; 1996.

(132) Wulff HR, Pedersen SA, Rosenberg R. Philosophy in medicine. Oxford (UK): Blackwell Scientific; 1986.

(133) Bakke PS, Gulsvik A. Work-related asthma: prevalence estimates by sex, age and smoking habits in a community sample. Int J Tuberc Lung Dis 2000;4(7):649-56.

(134) Thorslund M, Wärneryd B, Östlin P. The work-relatedness of disease: workers' own assessment. Sociol Health Illn 1992;14(1):57-72.

(135) Balmes J, Becklake M, Blanc P, Henneberger P, Kreiss K, Mapp C et al. American Thoracic Society Statement: Occupational contribution to the burden of airway disease. Am J Respir Crit Care Med 2003;167(5):787-97.

(136) Hilt B, Kvenild K, Stenersen H. Arbeidsrelaterte sykdommer i allmennpraksis [Illness related to occupational factors encountered in a general practice setting]. Tidsskr Nor Lægeforen 2003;123(15):2065-7.

(137) Tellnes G, Bruusgaard D, Sandvik L. Occupational factors in sickness certification. Scand J Prim Health Care 1990;8(1):37-44.

(138) Leira HL, Bratt U, Slåstad S. Notified cases of occupational asthma in Norway: exposure and consequences for health and income. Am J Ind Med 2005;48(5):359-64.

(139) Hagen K, Zwart JA, Svebak S, Bovim G, Jacob SL. Low socioeconomic status is associated with chronic musculoskeletal complaints among 46,901 adults in Norway. Scand J Public Health 2005;33(4):268-75.

(140) Brekke M, Hjortdahl P, Kvien TK. Severity of musculoskeletal pain: relations to socioeconomic inequality. Soc Sci Med 2002;54(2):221-8.

(141) Dionne CE, Von KM, Koepsell TD, Deyo RA, Barlow WE, Checkoway H. Formal education and back pain: a review. J Epidemiol Community Health 2001;55(7):455-68.

(142) Claussen B, Dalgard OS, Bruusgaard D. Disability pensioning: Can ethnic divides be explained by occupation, income, mental distress, or health? Scand J Public Health 2009;37(4):395-400.

(143) Galobardes B, Shaw M, Lawlor DA, Lynch JW, Davey Smith G. Indicators of socioeconomic position (part 1). J Epidemiol Community Health 2006;60(1):7-12.

(144) Næss Ø, Claussen B, Thelle DS, Smith GD. Four indicators of socioeconomic position: relative ranking across causes of death. Scand J Public Health 2005;33(3):215-21.

(145) Galobardes B, Lynch J, Davey Smith G. Measuring socioeconomic position in health research. Br Med Bull 2007;81-82:21-37.

(146) Erikson RR, Goldthorpe JH, Portocarero L. Intergenerational class mobility in three Western European societies: England, France and Sweden. Br J Sociol 1979;30(4):415-41.

(147) Galobardes B, Shaw M, Lawlor DA, Lynch JW, Davey Smith G. Indicators of socioeconomic position (part 2). J Epidemiol Community Health 2006;60(2):95-101.

(148) Lundberg O. Causal explanations for class inequality in health - An empirical analysis. Soc Sci Med 1991;32(4):385-93.

(149) Statistics Norway. Labour Force Survey. http://www.ssb.no/aku/tab-2009-04-29-04.html (Date accessed 2 June 2009).

(150) Statistics Norway. Level of living survey. Work conditions. StatBank. http://statbank.ssb.no/statistikkbanken/Default_FR.asp?PXSid=0&nvl=true&PLanguage=0&tilside=selecttable/hovedtabellHjem.asp&KortnavnWeb=arbmiljo (Date accessed 2 June 2009).

(151) Natvig B, Nessiøy I, Bruusgaard D, Rutle O. Musculoskeletal complaints in a local community. Eur J Gen Pract 1995;1:25-8.

(152) Treaster DE, Burr D. Gender differences in prevalence of upper extremity musculoskeletal disorders. Ergonomics 2004;47(5):495-526.

(153) Punnett L, Herbert R. Work-related musculoskeletal disorders: Is there a gender differential, and if so, what does it mean? In: Goldman MB, Hatch MC, editors. Women and Health. New York: Academic Press; 2000. p. 474-92.

(154) Hooftman W. Gender differences in work-related risk factors for musculoskeletal symptoms and absenteeism. Thesis. Amsterdam (Netherlands): VU University Medical Center; 2006.

(155) de Zwart BC, Frings-Dresen MH, Kilbom Å. Gender differences in upper extremity musculoskeletal complaints in the working population. Int Arch Occup Environ Health 2001;74(1):21-30.

(156) Westberg H. Where are women in today's workplace? In: Kilbom Å, Messing K, Bildt Thorbjörnsson C, editors. Women's health at work. Solna (Sweden): National Institute for Working Life; 1998. p. 27-57.

(157) Kilbom Å, Messing K. Aches and pains - an affliction of women. Work-related musculoskeletal disorders. In: Kilbom Å, Messing K, Bildt Thorbjörnsson C, editors. Women's health at work. Solna (Sweden): National Institute for Working Life; 1998. p. 203-27.

(158) Dahlberg R, Karlqvist L, Bildt C, Nykvist K. Do work technique and musculoskeletal symptoms differ between men and women performing the same type of work tasks? Appl Ergon 2004;35(6):521-9.

(159) Nordander C, Ohlsson K, Balogh I, Hansson GÅ, Axmon A, Persson R et al. Gender differences in workers with identical repetitive industrial tasks: exposure and musculoskeletal disorders. Int Arch Occup Environ Health 2008;81(8):939-47.

(160) Strazdins L, Bammer G. Women, work and musculoskeletal health. Soc Sci Med 2004;58(6):997-1005.

(161) Craft RM, Mogil JS, Maria Aloisi A. Sex differences in pain and analgesia: the role of gonadal hormones. Eur J Pain 2004;8(5):397-411.

(162) Punnett L, Bergqvist U. Musculoskeletal disorders in visual display unit work: gender and work demands. Occup Med 1999;14(1):113-24, iv.

(163) Roquelaure Y, Ha C, Leclerc A, Touranchet A, Sauteron M, Melchior M et al. Epidemiologic surveillance of upper-extremity musculoskeletal disorders in the working population. Arthritis Rheum 2006;55(5):765-78.

(164) Shiri R, Miranda H, Heliovaara M, Viikari-Juntura E. Physical work load factors and carpal tunnel syndrome: a population-based study. Occup Environ Med 2009;66(6):368-73.

(165) Punnett L, Fine LJ, Keyserling WM, Herrin GD, Chaffin DB. Shoulder disorders and postural stress in automobile assembly work. Scand J Work Environ Health 2000;26(4):283-91.

(166) Wieslander G, Norback D, Gothe CJ, Juhlin L. Carpal tunnel syndrome (CTS) and exposure to vibration, repetitive wrist movements, and heavy manual work: a case-referent study. Br J Ind Med 1989;46(1):43-7.

I

Occupational Medicine 2006;**56:**371–379
Published online 24 May 2006 doi:10.1093/occmed/kql034

Self-reported work-related health problems from the Oslo Health Study

Ingrid Sivesind Mehlum[1], Helge Kjuus[1], Kaj Bo Veiersted[1] and Ebba Wergeland[2]

Background	Lack of knowledge about the occurrence of work-related health problems in the general population makes it difficult to estimate the potential for their prevention in the workplace.
Aims	To examine the prevalence of self-reported work-related health problems among adult citizens of Oslo, Norway.
Methods	The study was part of the Oslo Health Study 2000–2001, in which all individuals in certain age cohorts were invited to a comprehensive health screening. All 30-, 40- and 45-year old subjects who attended the screening were asked if they had experienced any of 11 common health problems in the past month, and whether they considered these to be work-related. Of the 26 074 invitees in these age cohorts, 8594 (33%) answered the questionnaire.
Results	Nearly 60% of subjects reported one or more work-related health problems, most commonly reported were pain in the neck/shoulders (38%) and low back pain (23%). Neck/shoulder pain was most frequently attributed to working conditions, by 74% of subjects with this problem; followed by arm pain (72%), fatigue (51%) and low back pain (50%). Work-related fractions for eczema and asthma symptoms were 23 and 18%, respectively. There were marked gender differences, but small age differences.
Conclusions	A substantial proportion of common health problems in the Oslo population were attributed to working conditions. This implies a large preventive potential and call for increased preventive efforts targeted at known risk factors in the workplace.
Key words	Epidemiology; occupational health; prevalence; prevention; questionnaire; self-reported work-related symptoms.

Introduction

There is a well-established relationship between certain working conditions and specific health problems [1–4]. Less is known about the occurrence of work-related health problems in the general population, and consequently the potential for their prevention at the work site. Such information may be obtained from several sources.

Risk ratios obtained from the epidemiological literature, combined with exposure prevalences, have been used to quantify the impact of working conditions on specific diseases, for example cancer [5], cardiovascular diseases [6], shoulder/neck conditions [7] and cause-specific mortality [8].

National registers of work-related diseases and injuries are another source for determining the health impact of occupational exposure [9,10]. However, the Norwegian registers are far from complete [11–13]. Although notification is required by law, only 3% of Norwegian general practitioners and <25% of occupational physicians reported work-related diseases to the Labour Inspection Authority in 2003.

Population surveys comprise a third source. Statistics Norway runs regular surveys on perceived work exposure and work-related health problems in representative samples of the Norwegian population [14]. Their samples, however, are too small to give reliable information about work-related health problems in subgroups of the population [15]. The Oslo Health Study provided an opportunity to examine a larger, regional sample of selected age cohorts.

The aim of the present study was to examine the occurrence of work-related health problems and their impact on the total burden of ill-health among Oslo citizens. We focused on cohorts aged 30, 40 and 45 years. Compared to older cohorts, their occupational exposures are nearer in time, and their health problems are more likely to reflect conditions prevailing in today's working

[1]National Institute of Occupational Health, Oslo, Norway.

[2]Directorate of Labour Inspection, Oslo, Norway.

Correspondence to: Ingrid Sivesind Mehlum, Department of Occupational Medicine and Epidemiology, National Institute of Occupational Health, PO Box 8149 Dep, N-0033 Oslo, Norway. Tel: +47 23 19 53 27; fax: +47 23 19 52 05; e-mail: ism@stami.no

life, amenable to prevention. Results were compared with corresponding results from the smaller, national Survey of Living Conditions 2000, by Statistics Norway.

Methods

The Oslo Health Study was conducted in 2000–2001 under the joint collaboration of the National Health Screening Service of Norway (now part of the Norwegian Institute of Public Health), the University of Oslo and the Municipality of Oslo. The study consisted of a central core project and 70 supplementary projects. All individuals in Oslo County born in 1970, 1960, 1955, 1940/41 and 1924/25 (40 888 in total) were invited by letter to attend a health screening.

The 26 074 citizens in the three youngest cohorts were selected for the present study (invitees). Of these, 10 711 attended a physical examination and/or filled in at least one questionnaire in the Oslo Health Study (attendees), and 8594 returned the questionnaire on work-related health problems (responders).

The main questionnaire was distributed with the letter of invitation, advising that it was available in 11 other languages. Two reminders were sent to non-responders, the second one inviting suburban citizens to mobile screening units in their neighbourhood. Assistance from field workers to complete the questionnaires was offered to citizens with poor Norwegian language skills. This main questionnaire was returned at the time of the health screening. Those unable to attend the screening were asked to return it by mail.

Supplementary questionnaires were distributed at the health screening with pre-stamped self-addressed envelopes. Attendees who did not return them were reminded once. All questionnaires were self-administered, and asked for information on health status, symptoms, diseases and various aspects of health behaviour [16].

One of the supplementary questionnaires included questions on work-related health problems, modified from questions used by Statistics Norway [14]. The introductory question, 'Have you experienced any of the following common health problems in the last month, and are they totally or partially caused by working conditions in your present or previous job?' was followed by a list of 11 commonly work-related health problems [1,13,14]:

(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 and
(xi) sleep disturbance, problems falling asleep.

Response categories were No, I have not experienced this; Yes, but not caused by work and Yes, totally or partially caused by work.

Data from Statistics Norway, Survey of Living Conditions 2000 were included for comparison. From a representative population sample of 4940 individuals aged 15–66 years, interviews were conducted with 3185 (64%) by telephone or in person [15]. Comparisons were restricted to the 1080 employed subjects aged 30–45 years: 523 women and 557 men.

From the Survey of Living Conditions 2000, the following questions were selected for analysis, corresponding to the questions in the Oslo Health Study: 'To what extent have you suffered from these common health problems? Have you in the last month suffered very much, suffered quite a lot, suffered somewhat, or not suffered from:

(i) asthma or other airway problems?
(ii) eczema or allergic skin rash?
(iii) pain in neck, shoulders or upper back?
(iv) pain in arms, wrists or hands?
(v) low back pain?
(vi) extraordinary tiredness or fatigue?'

Confirmative answers led to a follow-up question: 'Is this totally or partially caused by your present job? Yes or No'. Only employed subjects were asked these questions. Comparisons of answers between the two surveys were therefore restricted to the 7640 employed responders in our study.

'Attendees' and 'responders' of the Oslo Health Study were compared with the 'invitees' on background variables, including socio-demographic characteristics based on public register data from Statistics Norway. The crude and adjusted odds ratios (ORs) for response among the invitees were estimated by logistic regression including all the socio-demographic variables as covariates.

Prevalences of self-reported 'health problems' and 'work-related health problems' were calculated as valid per cent, excluding missing answers. The 'work-related fraction' was calculated as the ratio between the two prevalences. Unstratified prevalences were adjusted for age and gender by direct standardization based on the distribution in the invited population. Data were otherwise stratified by gender and age, grouping subjects aged 40 and 45 years together. In our analyses of Statistics Norway, Survey of Living Conditions 2000, the first three response categories (suffered very much/suffered quite a lot/suffered somewhat) were grouped together as 'suffered'. Observed proportions were compared using the

chi-square test. A two-tailed P-value < 0.05 was considered statistically significant. Analyses were performed using the statistical software SPSS 11.5 for Windows.

The study protocol was approved by the Regional Committee for Medical Research Ethics and the Norwegian Data Inspectorate.

Results

Table 1 shows attendance and response according to selected background variables. A total of 8594 subjects returned the supplementary questionnaire on work-related health problems, representing 80% of those who attended the health screening, and 33% of the invited population. The response frequency was higher among females than among males, and increased with age. Individuals with low education, low income, disability benefit or of non-Western origin, were under-represented. The low response of subjects with low education, low income or disability benefit was partly due to low attendance. Subjects born in non-Western countries had a low response, despite near average attendance, due to failure to return the questionnaire. Adjusting for all background variables did not markedly change the overall pattern of response in most subgroups, but country of birth and low income became less important. Item response frequencies among the 8594 responders were 96–98%.

The prevalences of self-reported health problems in the past month, standardized by age and gender, are shown in Figure 1. Pain in the neck/shoulders and low back pain were most commonly reported, by 52 and 46% of subjects, respectively, followed by fatigue (39%), nose symptoms (36%) and sleep disturbance (30%).

While 85% of subjects reported one or more of the health problems listed, nearly 60% attributed one or more of them to present or previous jobs. The most frequently reported work-related health problem was pain in the neck/shoulders (38%), followed by low back pain (23%), arm pain (pain in elbow, forearm, hand) (20%) and fatigue (20%).

The work-related fraction of the total prevalence was highest for pain in the neck/shoulders (74%) and arm pain (72%), followed by fatigue (51%) and low back pain (50%). The work-related fractions for impaired hearing, eczema and asthma symptoms were 28, 23 and 18%, respectively.

In Table 2, the gender-specific prevalences of the health problems, the work-related health problems, and the work-related fractions are presented. In Table 3, the material is stratified according to age, using two age strata (30 and 40/45 years of age).

Women reported pain in the neck/shoulders, arms and lower back more frequently than men, but the fractions perceived as work-related were the same. Total prevalences of pain were higher in the oldest age group, but the age difference for work-related pain was statistically significant for arm pain only.

Work-related respiratory symptoms were more frequent in men than in women, and more frequent in the oldest age group. Women reported eczema somewhat more often than men, but the work-related fractions were similar, and there were no age differences. Impaired hearing was more prevalent among men and in the oldest age group, and men had a higher work-related fraction.

Table 4 shows results from the Survey of Living Conditions 2000, compared with results among employed subjects in the Oslo Health Study. The mean age in the two surveys was 37.2 and 38.1 years, respectively. The prevalence estimates were similar or somewhat lower in the Survey of Living Conditions compared to the Oslo Health Study, while most work-related fractions were similar or higher. The gender differences in prevalence estimates were comparable in the two surveys.

Discussion

In this study of 8594 Oslo citizens, aged 30, 40 and 45 years, self-reported work-related health problems were highly prevalent. Nearly 60% reported one or more work-related health problem, and a high proportion of reported health problems were attributed to working conditions.

The low attendance in the study is a matter of concern. In recent years, the response frequencies of population surveys have declined in Norway, as well as in other countries [17]. As it affects all projects in the Oslo Health Study, possible selection bias has been thoroughly examined. Søgaard *et al.* [17] found that self-rated health, mental health (Hopkins Symptom Check List), smoking and body mass index in the attendees differed only slightly from estimated prevalence values in the invitees, when weighted by the probability of attendance based on background variables. Estimates based on the assumption that the prevalences among non-attending individuals differed from those attending by no more than 50%, differed only moderately from observed values. Søgaard *et al.* concluded that self-selection according to socio-demographic variables had little impact on the prevalence estimates of these examined health-related variables. As we have similar outcome variables, we assume that their conclusion is valid also for this study.

Attendance according to disability benefit indicates that healthy persons were over-represented among attendees in the Oslo Health Study (Table 1). Among the responders of the supplementary questionnaire, 85% reported their present state of health to be very good or good, against 73% of those who answered the main, but not the supplementary, questionnaire. The response was also lower among individuals born in non-Western countries, a subgroup that reported higher frequencies of work-related health problems than individuals of

Table 1. Attendance (attended at screening and/or submitted at least one questionnaire) and response to supplementary questionnaire among invited subjects aged 30, 40 and 45 years (n = 26 074) in the Oslo Health Study 2000–2001

	Number invited[a]	Attendance (%)[b]	Responders		Crude OR	Adjusted OR	(95% CI)
			% attendees[b]	% invited[b]			
All	26 074	41	80	33			
Sex							
Women	12 810	46	81	38	1.00	1.00	
Men	13 264	36	79	28	0.65	0.64	(0.61–0.68)
Age							
45	6763	47	80	37	1.00	1.00	
40	7907	44	80	35	0.90	0.90	(0.84–0.97)
30	11 404	36	80	29	0.68	0.66	(0.62–0.72)
Marital status							
Married	10 264	46	78	36	1.00	1.00	
Unmarried/cohabitant	12 532	38	83	32	0.84	0.84	(0.78–0.90)
Widowed	130	47	79	37	1.06	1.12	(0.76–1.64)
Separated/divorced	3052	37	79	29	0.76	0.71	(0.64–0.78)
Registered partnership	82	44	89	39	1.16	1.11	(0.68–1.81)
Country of birth							
Norway	20 214	42	85	36	1.00	1.00	
Western countries[c]	1748	37	84	31	0.80	1.00	(0.89–1.12)
Non-Western	4112	39	53	21	0.50	0.62	(0.56–0.68)
Region of residence							
Outer east	10 019	46	78	36	1.00	1.00	
Outer west	5854	43	84	36	1.00	0.76	(0.71–0.82)
Inner west	3886	36	85	30	0.76	0.66	(0.61–0.72)
Inner east	4625	39	80	31	0.80	0.84	(0.78–0.92)
Education							
College/university	11 456	45	86	38	1.00	1.00	
Upper secondary	10 218	40	79	31	0.73	0.69	(0.65–0.74)
Lower secondary	2671	32	67	22	0.44	0.43	(0.39–0.48)
Unknown	1727	38	66	25	0.53	0.25	(0.21–0.31)
Total income (NOK)							
400 000+	4500	38	84	32	1.00	1.00	
199 000–399 000	13 845	44	83	37	1.22	1.34	(1.24–1.46)
100 000–199 000	4409	37	73	27	0.78	1.05	(0.94–1.17)
<100 000	2855	29	69	20	0.53	0.72	(0.64–0.82)
Disability benefit							
No	24 756	41	81	33	1.00	1.00	
Yes	921	30	67	20	0.51	0.57	(0.47–0.68)
Single parent benefit							
No	25 208	40	81	33	1.00	1.00	
Yes	469	36	69	25	0.69	0.77	(0.61–0.96)
Rehabilitation benefit							
No	25 317	40	81	33	1.00	1.00	
Yes	360	40	71	28	0.82	0.80	(0.62–1.02)
Sickness benefit							
No	24 668	40	81	33	1.00	1.00	
Yes	1009	40	77	30	0.91	0.82	(0.71–0.95)
Unemployment benefit							
No	24 913	40	81	33	1.00	1.00	
Yes	764	34	76	26	0.73	0.88	(0.74–1.05)

Association between socio-demographic variables and response among invited subjects as crude OR and adjusted for all variables in the table by logistic regression [95% confidence interval (CI) for the adjusted OR].

[a]The total number is <26 074 for some socio-demographic variables due to missing information.

[b]% represents valid per cent, excluding missing answers.

[c]Western countries (excluding Norway): Denmark, Greenland, Finland, Faeroe Islands, Iceland, Sweden, Belgium, France, Greece, Ireland, Italy, Malta, Netherlands, Portugal, Spain, Great Britain and Northern Ireland, Switzerland, Germany, Austria, Israel, Cyprus, Canada, United States, Australia, New Zealand.

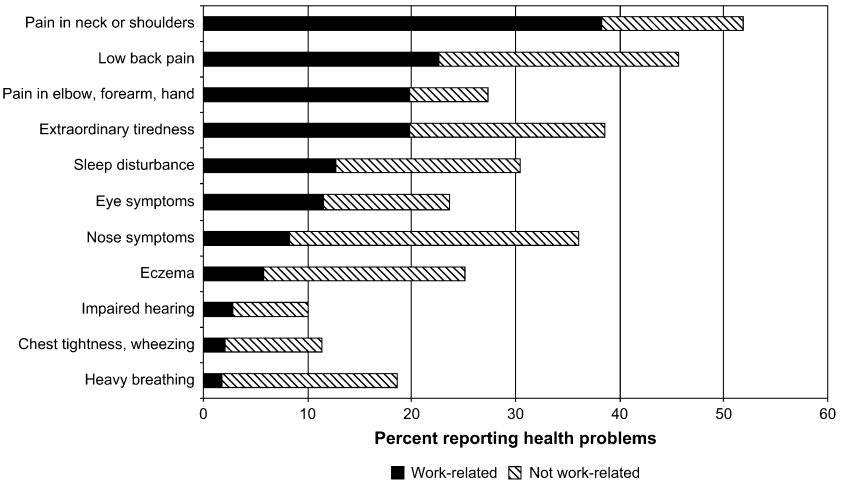


Figure 1. Health problems experienced in the past month according to work-relatedness, as reported by citizens of Oslo aged 30, 40 and 45 years (n = 8594). Prevalences adjusted for gender and age by direct standardization based on the distribution in the invited population. The Oslo Health Study 2000–2001.

Table 2. Prevalence of self-reported health problems in the past month and their work-relatedness; women (n = 4839) and men (n = 3755) aged 30, 40 and 45 years in the Oslo Health Study 2000–2001

Health problems	Self-reported health problems					Perceived as work-related					Work-related fraction[a]		
	Women		Men			Women		Men			Women	Men	
	n	%[b]	*n*	%[b]		*n*	%[b]	*n*	%[b]	Gender differences	%	Gender differences	
Pain in neck or shoulders	2844	61	1579	43	***	2111	45	1160	32	***	74	73	
Low back pain	2269	49	1583	43	***	1101	24	801	22	*	49	51	
Pain in elbow, forearm, hand	1418	31	878	24	***	1036	22	629	17	***	73	72	
Fatigue	2030	44	1232	34	***	981	21	676	18	**	48	55	***
Sleep disturbance	1504	32	1051	29	***	576	12	483	13		38	46	***
Eye symptoms	1213	26	781	21	***	598	13	372	10	***	49	48	
Nose symptoms	1759	38	1260	34	***	446	10	254	7	***	25	20	***
Eczema	1221	26	876	24	*	299	6	184	5	**	25	21	
Impaired hearing	389	8	422	12	***	86	2	133	4	***	22	32	**
Chest tightness, wheezing	526	11	417	11		76	2	90	2	**	14	22	**
Heavy breathing	966	21	607	16	***	67	1	80	2	*	7	13	***

[a]The fraction of the total prevalence represented by the work-related health problems.

[b]% represents valid per cent, excluding missing answers.

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

Western origin (not shown). Thus, the response was lower in subgroups with poorer health, which may imply that our prevalence estimates are conservative.

Self-administered questionnaires tend to be returned primarily by those who perceive the questions as relevant to their own situation [18]. However, the questions about work-related health problems were only a small part of the supplementary questionnaire. Bias due to selection of individuals with self-perceived work-related health problems is therefore unlikely.

The prevalences of health problems in the Oslo Health Study were similar to, or somewhat higher than, the corresponding prevalences in the Survey of Living Conditions 2000. Socio-demographic differences among people living in the urban, more multicultural Oslo and a representative sample of the Norwegian population

Table 3. Prevalence of self-reported health problems in the past month by gender and age group (30 and 40/45 years) (n = 8594) in the Oslo Health Study 2000–2001

Health problems	Self-reported health problems					Perceived as work-related				
	Women			Men		Women			Men	
	Age 30 years (n = 1855)	Age 40/45 years (n = 2984)		Age 30 years (n = 1455)	Age 40/45 years (n = 2300)	Age 30 years (n = 1855)	Age 40/45 years (n = 2984)		Age 30 years (n = 1455)	Age 40/45 years (n = 2300)
	%[a]	%[a]	Age differences	%[a]	%[a] Age differences	%[a]	%[a]	Age differences	%[a]	%[a] Age differences
Pain in neck or shoulders	58	63	***	39	45 ***	44	46		31	32
Low back pain	46	50	*	38	46 ***	24	24		21	22
Pain in elbow, forearm, hand	26	34	***	20	27 ***	20	24	**	15	19 **
Fatigue	45	43		32	35	22	20		19	18
Sleep disturbance	28	35	***	25	31 ***	12	12		12	14
Eye symptoms	26	26		22	21	13	13		10	10
Nose symptoms	39	37		36	33	10	9		7	7
Eczema	26	26		24	24	6	6		5	5
Impaired hearing	6	10	***	9	13 ***	2	2		3	4 *
Chest tightness, wheezing	9	13	***	8	14 ***	1	2		2	3 **
Heavy breathing	16	24	***	12	20 ***	1	2	*	2	2

[a]% represents valid per cent, excluding missing answers.

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

Table 4. Prevalence of self-reported health problems in the past month and their work-relatedness for employed women (n = 523) and men (n = 557) aged 30–45 years, Statistics Norway, Survey of Living Conditions 2000, and corresponding results from the Oslo Health Study (4167 women and 3473 men)—in brackets, as the questions are not identical

Health problems	Self-reported health problems				Perceived as work-related				Work-related fraction[a]			
	Women		Men		Women		Men		Women		Men	
	%[b]	(%)	%[b]	(%)	%[b]	(%)	%[b]	(%)	%	(%)	%	(%)
Pain in neck, shoulders or upper back	50	(61)	37	(42)	34	(48)	27	(32)	68	(79)	74	(76)
Low back pain	31	(47)	27	(42)	14	(24)	17	(22)	46	(51)	64	(51)
Pain in arms, wrists or hands	29	(30)	22	(23)	21	(23)	16	(18)	74	(77)	75	(75)
Extraordinary tiredness or fatigue	30	(43)	28	(33)	15	(22)	19	(19)	50	(52)	68	(57)
Eczema or allergic skin rash	16	(26)	11	(23)	5	(6)	3	(5)	35	(25)	33	(21)
Asthma or other airway problems	10	(11)	8	(10)	3	(2)	2	(2)	31	(14)	23	(23)

[a]The fraction of the total prevalence represented by the work-related health problems.

[b]% represents valid per cent, excluding missing answers.

could explain some of the observed differences. Omitting non-Western subjects in the Oslo Health Study reduced the differences between the two surveys (not shown). Varying distribution of industries and occupations and somewhat different design and questions could also have contributed to the differences between the two surveys. However, the overall consistency does not indicate a serious selection problem in the low attendance of the present study.

Musculoskeletal pain was the health problem most frequently perceived as work-related, with work-related fractions ranging from 49 to 74%, which is compatible with other studies [19,20]. The work-related fraction of asthma symptoms was 18% (age and gender standardized). An official statement of the American Thoracic Society, based on a review of 21 articles, concluded that 15% was a reasonable estimate of the occupational contribution to the population burden of adult asthma [21]. Our result is close to their conclusion, and emphasizes the importance of work in the causation or exacerbation of asthma.

In Norway, the employment level among women is high; in 2004, 81% of women and 87% of men aged 30–44 years were employed [22]. Work-related impaired hearing and respiratory symptoms were more frequent in men, compatible with men's work exposure [14]. Pain in the neck/shoulders, arms and lower back were more frequent in women. This is in accordance with other studies [19,23–25], and has been explained by risk factors, both at work and at home [26–29].

The prevalences of health problems were usually higher in the oldest age group, but for work-related health problems, there were only small prevalence differences. Reasons for this could be that the age interval is narrow and that subjects with work-related health problems may change to less harmful jobs or leave work, and thus non-persistent health problems may be reduced. However, for work-related respiratory symptoms and impaired hearing, which tend to persist after exposure ceases, we found higher prevalences in the oldest age group. Work-related pain in the elbow/forearm/hand was also more prevalent in the oldest age group, which may suggest ongoing exposure or the persistence of pain after reduced exposure.

Our data reflect self-reported health problems and their perceived work-relatedness. We have no further information on the type, severity and work-relatedness of the health problems. People may vary as to what health problems they will report. Bjerkedal and Bakketeig [30] found acceptable agreement between patients' and physicians' reports of sickness, but some groups of diagnoses, especially mental and musculoskeletal disorders, tended to be under-reported by patients' compared to physicians' reporting based on their health records.

Attribution bias may influence reporting, i.e. the assessment of work-relatedness could reflect the attitudes and interests of the person who makes the assessment [31,32]. The responders in population-based surveys have nothing to gain or to fear by reporting their health problems as work-related. Thus, we do not believe that such interests have affected our results.

In a Norwegian study among employed patients in general practice, 40% of women and 54% of men reported their current illness to be work-related [33]. In another study, physical workload and psychological factors were assessed to have contributed to 48 and 32% of sickness certification cases, respectively [34]. These studies indicate that work-related health problems affect people's work and daily activities, and lead to the need for medical help and sick leave.

In this population-based study, a substantial proportion of 30-, 40- and 45-year old Oslo citizens reported work-related health problems in the past month. These results suggest a large potential for prevention by reduction of known risk factors in the workplace. Self-report

of work-related health problems may yield different prevalence estimates from data obtained by clinical examinations. This warrants further exploration.

Acknowledgements

This study was supported financially by The Confederation of Norwegian Business and Industry's Working Environment Fund, Oslo, Norway; The Directorate of Labour Inspection, Oslo, Norway; and The National Institute of Occupational Health, Oslo, Norway. The data collection was conducted as part of the Oslo Health Study 2000–2001 in collaboration with the National Health Screening Service of Norway (now part of the Norwegian Institute of Public Health). Data from Statistics Norway, Survey of Living Conditions 2000, were generously placed at our disposal by The Norwegian Social Science Data Services (NSD). We would also like to thank Tor Norseth and Magne Thoresen for their comments on the manuscript.

Conflicts of interest

None declared.

References

1. World Health Organization. *Identification and Control of Work-Related Diseases. Report of a WHO Expert Committee*. Technical Report Series. No. 714. Geneva: WHO, 1985.
2. Toren K, Brisman J, Olin AC, Blanc PD. Asthma on the job: work-related factors in new-onset asthma and in exacerbations of pre-existing asthma. *Respir Med* 2000; **94:**529–535.
3. National Research Council. *Work-Related Musculoskeletal Disorders. Report, Workshop Summary, and Workshop Papers.* Washington, DC: National Academy Press, 1999.
4. Coggon D. Occupational cancer in the United Kingdom. *Environ Health Perspect* 1999;**107(Suppl. 2):**239–244.
5. Andersen A, Barlow L, Engeland A, Kjærheim K, Lynge E, Pukkala E. Work-related cancer in the Nordic countries. *Scand J Work Environ Health* 1999;**25(Suppl. 2):**1–116.
6. Olsen O, Kristensen TS. Impact of work environment on cardiovascular diseases in Denmark. *J Epidemiol Community Health* 1991;**45:**4–9.
7. Punnett L, Wegman DH. Work-related musculoskeletal disorders: the epidemiologic evidence and the debate. *J Electromyogr Kinesiol* 2004;**14:**13–23.
8. Nurminen M, Karjalainen A. Epidemiologic estimate of the proportion of fatalities related to occupational factors in Finland. *Scand J Work Environ Health* 2001;**27:** 161–213.
9. Cherry NM, Meyer JD, Holt DL, Chen Y, McDonald JC. Surveillance of work-related diseases by occupational physicians in the UK: OPRA 1996–1999. *Occup Med (Lond)* 2000;**50:**496–503.
10. Cherry NM, McDonald JC. The incidence of work-related disease reported by occupational physicians, 1996–2001. *Occup Med (Lond)* 2002;**52:**407–411.
11. Wergeland E, Bjerkedal T, Andersen A, Mowe G. Bruk av yrkesskadetrygd ved yrkessykdom [Use of occupational disease benefits]. *Tidsskr Nor Lægeforen* 1997;**117:**211–216.
12. Gravseth HM, Wergeland E, Lund J. Underrapportering av arbeidsskader til Arbeidstilsynet [Underreporting of occupational injuries to the Labour Inspection]. *Tidsskr Nor Lægeforen* 2003;**123:**2057–2059.
13. Nordic Council of Ministers. *Anmälda arbetssjukdomar i Norden 1990–1992* [Notified work-related diseases in the Nordic countries 1990–1992]. TemaNord 1996:545. København: Nordic Council of Ministers, 1996.
14. Statistics Norway. *Survey of Living Conditions 2000. Working Environment.* Oslo, Norway: Statistics Norway, 2001.
15. Vågane, L. *Samordnet levekårsundersøkelse 2000—tverrnsittsundersøkelsen. Dokumentasjonsrapport [Coordinated Survey of Living Conditions 2000—Cross-Sectional Survey. Documentation Report]*. 2001/34. Oslo, Norway: Statistics Norway, 2001.
16. Norwegian Institute of Public Health. *The Oslo Health Study.* http://www.fhi.no/artikler/?id=54464 (date last accessed 16 May 2006).
17. Søgaard AJ, Selmer R, Bjertness E, Thelle D. The Oslo Health Study: the impact of self-selection in a large, population-based survey. *Int J Equity Health* 2004;**3:**3.
18. Dickinson CE, Campion K, Fostyer AF, Newman SJ, O'Rourke AMT, Thomas PG. Questionnaire development: an examination of the Nordic musculoskeletal questionnaire. *Appl Ergon* 1992;**23:**197–201.
19. Räsänen K, Notkola V, Husman K. Perceived work conditions and work-related symptoms among employed Finns. *Soc Sci Med* 1997;**45:**1099–1110.
20. Thorslund M, Wärneryd B, Östlin P. The work-relatedness of disease: workers' own assessment. *Sociol Health Illn* 1992;**14:**57–72.
21. Balmes J, Becklake M, Blanc P *et al.* American Thoracic Society Statement: occupational contribution to the burden of airway disease. *Am J Respir Crit Care Med* 2003;**167:**787–797.
22. Statistics Norway. *Labour Force Survey.* Olso, Norway: Statistics Norway, 2005.
23. Natvig B, Nessiøy I, Bruusgaard D, Rutle O. Musculoskeletal complaints in a local community. *Eur J Gen Pract* 1995;**1:**25–28.
24. de Zwart BC, Frings-Dresen MH, Kilbom Å. Gender differences in upper extremity musculoskeletal complaints in the working population. *Int Arch Occup Environ Health* 2001;**74:**21–30.
25. Weiner J, Bastin M. *Arbetsorsakade besvär 2003 [Work-Related Disorders 2003]*. AM 43 SM 0301. Solna, Sweden: Swedish Work Environment Authority, Statistics Sweden, 2003.
26. Strazdins L, Bammer G. Women, work and musculoskeletal health. *Soc Sci Med* 2004;**58:**997–1005.
27. Messing K. Ergonomic studies provide information about occupational exposure differences between women and men. *J Am Med Womens Assoc* 2000;**55:**72–75.
28. Kilbom Å, Messing K. Aches and pains—an affliction of women. Work-related musculoskeletal disorders. In: Kilbom Å, Messing K, Bildt Thorbjörnsson C, ed. *Women's Health at Work.* Solna, Sweden: National Institute for Working Life, 1998; 203–227.

29. Statistics Norway. *Survey of Living Conditions 2003. Working Environment.* Olso, Norway: Statistics Norway, 2004.
30. Bjerkedal T, Bakketeig L. Påliteligheten av intervjuopplysninger om helseforhold [Validity of health interview surveys]. *Tidsskr Nor Lægeforen* 1975;**95:**927–931.
31. Abba K, Clarke S, Cousins R. Assessment of the potential effects of population changes in attitudes, awareness and beliefs on self-reporting of occupational ill-health. *Occup Med (Lond)* 2004;**54:**238–244.
32. Wulff HR, Pedersen SA, Rosenberg R. *Philosophy in Medicine*. Oxford: Blackwell Scientific, 1986.
33. Hilt B, Kvenild K, Stenersen H. Arbeidsrelaterte sykdommer i allmennpraksis [Illness related to occupational factors encountered in a general practice setting]. *Tidsskr Nor Lægeforen* 2003;**123:**2065–2067.
34. Tellnes G, Bruusgaard D, Sandvik L. Occupational factors in sickness certification. *Scand J Prim Health Care* 1990;**8:**37–44.

II

Original article

Scand J Work Environ Health 2008;34(4);250–259

Are occupational factors important determinants of socioeconomic inequalities in musculoskeletal pain?

by Ingrid Sivesind Mehlum, MD,[1] Petter Kristensen, PhD,[1] Helge Kjuus, PhD,[1] Ebba Wergeland, PhD[2]

Mehlum IS, Kristensen P, Kjuus H, Wergeland E. Are occupational factors important determinants of socioeconomic inequalities in musculoskeletal pain? *Scand J Work Environ Health* 2008;34(4);250–259.

Objectives The aim of this study was to quantify socioeconomic inequalities in low-back pain, neck–shoulder pain, and arm pain in the general working population in Oslo and to examine the impact of job characteristics on these inequalities.

Methods All economically active 30-, 40-, and 45-year-old persons who attended the Oslo health study in 2000–2001 and answered questions on physical job demands, job autonomy, and musculoskeletal pain were included (N=7293). Occupational class was used as an indicator of socioeconomic status. The lower occupational classes were compared with higher grade professionals, and prevalences, prevalence ratios, prevalence differences, and population attributable fractions were calculated.

Results There were marked, stepwise socioeconomic gradients for musculoskeletal pain, steeper for the men than for the women. The relative differences (prevalence ratios) were larger for low-back pain and arm pain than for neck–shoulder pain. The absolute differences (prevalence differences) were the largest for low-back pain. Physical job demands explained a substantial proportion of the absolute occupational class inequalities in low-back pain, while job autonomy was more important in explaining the inequalities in neck–shoulder pain and arm pain. The estimated population attributable fractions supported the impact of job characteristics at the working population level, especially for low-back pain.

Conclusions In this cross-sectional study, physical job demands and job autonomy explained a substantial proportion of occupational class inequalities in self-reported musculoskeletal pain in the working population in Oslo. This finding indicates that the workplace may be an important arena for preventive efforts to reduce socioeconomic inequalities in musculoskeletal pain.

Key terms arm pain; job autonomy; low-back pain; neck pain; occupational class; occupational health; physical job demands; questionnaire; self-reported symptom; shoulder pain.

Socioeconomic inequalities in health are well documented. The impact of work conditions on socioeconomic inequalities has been studied for various health outcomes [eg, mortality (1), coronary heart disease (2), self-rated general health (3–8), and mental health (8)]. A few studies have examined the impact of work conditions on socioeconomic inequalities in musculoskeletal disorders, measured as physician-diagnosed disorders (9), self-reported disorders diagnosed by a physician (10), sickness absence (11, 12), or disability pensioning (13). Aittomäki et al (10) showed that the occupational class-gradient in musculoskeletal disorders was largely explained by physical demands at work. Melchior et al (9) found that physical work factors accounted for over 50% of the differences between manual workers and other workers in physician-diagnosed upper-limb disorders, higher for some diagnoses. Melchior et al (11) also reported that work conditions explained approximately 25% of the occupational class-gradients in musculoskeletal-related sickness absence. Hagen et al (13) found that the inverse association between education and occupational disability from back pain was partly mediated through work conditions. However, data on the impact of different occupational factors on socioeconomic inequalities in musculoskeletal pain in specific body regions have rarely been reported.

The Oslo health study, in 2000–2001, of which our present study is a part, was initiated to examine the health status and socioeconomic health inequalities among Oslo citizens (14). Previous studies have shown large geographic and socioeconomic inequalities in Oslo (15, 16). We have recently reported high prevalences of

1 National Institute of Occupational Health, Oslo, Norway.
2 Norwegian Labour Inspection Authority, Oslo, Norway.

Reprint requests to: Dr I Sivesind Mehlum, National Institute of Occupational Health, PO Box 8149 Dep, N-0033 Oslo, Norway. [E-mail: ism@stami.no]

work-related health problems in this population (17). There is evidence that certain job characteristics, such as physical job demands and job autonomy, are risk factors for musculoskeletal disorders (18). Lower social classes tend to have higher prevalences of harmful work conditions, which can partly explain socioeconomic inequalities in health (4, 5, 9, 10). These issues need to be explored further.

The aim of our present study was to quantify socioeconomic inequalities in low-back pain, neck–shoulder pain, and arm pain in the general working population in Oslo and to examine the impact of physical job demands and job autonomy on these inequalities. Our hypothesis was that musculoskeletal pain is associated with occupational class and that this association can partly be explained by job characteristics and may vary between body regions.

Study population and methods

Study population

The Oslo health study, a cross-sectional population study, was conducted in 2000–2001 in joint collaboration between the Norwegian Institute of Public Health, the University of Oslo, and the municipality of Oslo. Everyone in Oslo County born in 1970, 1960, 1955, 1940–1941, and 1924–1925 were invited by letter to attend a health screening, and the three youngest cohorts were selected for our present study (N=26 074). Of these people, 10 712 (41%) attended a physical examination or filled out at least one questionnaire in the Oslo health study (17). An age-specific supplementary questionnaire, which included questions on musculoskeletal pain, was returned by 8594 persons (33%). The response frequency was higher among the women than among the men, and it increased with age. Persons with little education, low income, disability benefit, or nonwestern origin were under-represented (17). We have studied the 7293 (28%) respondents to this questionnaire with data on musculoskeletal pain, occupation, and job characteristics, 4042 women and 3251 men (table 1).

Questionnaires and study outcome

The main questionnaire was distributed with the letter of invitation. Two supplementary questionnaires were handed out at the health screening with pre-stamped self-addressed envelopes. The questionnaires asked for information on health status, symptoms, diseases, and various aspects of health behavior (14). The questions on musculoskeletal pain were similar to those used by Statistics Norway in regular national surveys (19). The introductory question, "Have you experienced any of the following common health problems in *the last month*?" was followed by a list of health problems; among them were pain in neck or shoulders, pain in the elbow, forearm or hand, and low-back pain (17).

Determinants

Occupational class. The indicator of socioeconomic status was based on questions on the participants' longest held occupation in the past 12 months, classified according to the Erikson–Goldthorpe–Portocarero (EGP) schema (20, 21). Because 61% of the women were in category III (routine nonmanual employees), this category was subdivided into IIIa (eg, nurses, teachers) and IIIb (eg, nursing assistants, shop salespersons), as in the full 11-class version of the EGP schema (21, 22). Only 27 women (0.6%) were in category V (lower-grade technicians and supervisors of manual workers). Category V and VI (skilled manual workers) were therefore collapsed, as in the 7-class version of the schema (21), and called "skilled workers" (eg, building trade workers, home helpers), leaving seven categories in the analyses (table 1).

Job characteristics. Two separate job characteristics were measured, each by one question. Physical job demands were measured by asking "How would you

Table 1. Distribution of the men (N=3251) and women (N=4042) according to the background factors and determinant variables.

	Men (%)	Women (%)
Age		
30 years	39	38
40 years	32	31
45 years	29	30
Country of birth		
Norway	85	86
Western countries	5	7
Nonwestern countries	10	7
Occupational class		
I Higher grade professionals	30	18
II Lower grade professionals	13	10
IIIa Routine nonmanual, higher	20	34
IIIb Routine nonmanual, lower	9	27
IV Self-employed workers	10	6
V+VI Skilled workers	10	2
VII Unskilled workers	8	3
Physical job demands		
Walking	19	25
Sedentary work	65	59
Walking and lifting	14	16
Heavy physical work	2	0
Job autonomy		
4 (high)	20	12
3	58	56
2	18	28
1 (low)	3	4

describe your current work?", followed by four mutually exclusive response categories: "mainly sedentary work", "work involving a lot of walking", "work involving a lot of walking and lifting", and "heavy physical work". Job autonomy was assessed with the question, "Can you *yourself* decide how your work should be organized?", with the following response categories: "no, not at all", "to a small degree", "yes, largely", and "yes, I decide myself", ranging from 1 (low) to 4 (high) autonomy in the analyses.

The general characteristics of the study population are shown in table 1. Gender differences were observed. Men were more frequently professionals, skilled or unskilled workers, had sedentary or heavy physical work, and had high job autonomy, while the women were more often routine nonmanual employees, had a lot of walking in their work, and had lower job autonomy.

The participants with heavy physical work generally had lower job autonomy, while those with sedentary work had higher autonomy (data not shown).

Statistical analyses

Analyses were performed using Stata/SE 9.2 software (www.stata.com). Associations between occupational class and musculoskeletal pain were estimated both as prevalence ratios and prevalence differences (23) with their corresponding 95% confidence intervals (95% CI), using the BINREG procedure (binomial regression) in Stata. Since musculoskeletal pain was prevalent, we did not use the more conventional odds ratios in the logistic regression (24, 25). Physical job demands and job autonomy were added separately and together in four multivariate models for each of the three study outcomes of low-back pain, neck–shoulder pain, and arm pain (pain in elbow, forearm, or hand). We calculated the percentage of change in the prevalence difference by adding each factor to the model. Model 1 included age (30, 40 or 45 years) and country of birth (Norway, western countries, or nonwestern countries) in addition to occupational class. Model 2 included physical job demands, in addition to model-1 factors. Model 3 included job autonomy, in addition to model-1 factors. Model 4 included all of the determinants.

The highest occupational class (I), work involving a lot of walking, and the highest category of job autonomy (4) were chosen as reference categories. Interaction between physical job demands and job autonomy was checked for, but the analyses were inconclusive due to collinearity.

The population attributable fraction (PAF) can be interpreted as the proportional reduction in the population prevalence in the hypothetical case that the whole population experiences the prevalence of the reference category (26). Population attributable fractions for occupational class were estimated in the AFLOGIT procedure in Stata after the inclusion of the determinants in the regression model as dummy variables (27).

Ethics approval

The study protocol was approved by the Norwegian Data Inspectorate and recommended by the Regional Committee for Medical Research Ethics.

Results

Prevalence of musculoskeletal pain

The distributions of low-back pain, neck–shoulder pain, and arm pain are shown in table 2 (men) and table 3 (women) according to occupational class and job characteristics. The lower occupational classes had higher prevalences of musculoskeletal pain. Among the unskilled workers, 62% of the women and 66% of the men reported low-back pain in the past month, while, among the higher grade professionals, the corresponding percentages were 43% and 35%, respectively. The prevalences were the lowest for arm pain and the highest for neck–shoulder pain. The differences between the three highest occupational classes (I, II and IIIa) were, in general, only minor. The prevalences for the self-employed workers (IV) were close to the overall prevalences of the population. Gender differences were the largest for the higher occupational classes.

The crude prevalences for musculoskeletal pain were the highest for the participants with heavy physical work. For both genders, low-back pain was the least prevalent among the participants with sedentary work, while arm pain was the least prevalent for both genders and neck–shoulder pain for women among the participants with a lot of walking in their work. Low autonomy was associated with musculoskeletal pain for both genders; the lower the autonomy, the higher the prevalence.

Relative and absolute differences in the prevalence of musculoskeletal pain

The relative socioeconomic gradient (prevalence ratio) was steeper for low-back pain and arm pain than for neck–shoulder pain, and steeper for the men (table 2) than for the women (table 3). For the unskilled workers, compared with the higher grade professionals, the prevalence ratio for low-back pain was 1.7 for the men and 1.3 for the women.

The absolute differences in occupational class (prevalence differences) in model 1 were also larger for the men (table 4) than for the women (table 5), and larger

Table 2. Prevalences and prevalence ratios for self-reported musculoskeletal pain according to occupational class, physical job demands, and job autonomy among the men. (95% CI = 95% confidence interval)

	N	Low-back pain			Neck–shoulder pain			Arm pain		
		Prevalence [a] (%)	Prevalence ratio [b]	95% CI	Prevalence [a] (%)	Prevalence ratio [b]	95% CI	Prevalence [a] (%)	Prevalence ratio [b]	95% CI
All men	3251	43	·	·	43	·	·	23	·	·
Occupational class										
I Higher grade professionals	975	35	1	··	40	1	··	20	1	··
II Lower grade professionals	435	33	1.0	0.8–1.1	42	1.1	0.9–1.2	21	1.0	0.8–1.3
IIIa Routine nonmanual, higher	634	39	1.1	1.0–1.3	37	0.9	0.8–1.1	17	0.9	0.7–1.1
IIIb Routine nonmanual, lower	301	52	1.5	1.3–1.7	50	1.2	1.0–1.3	26	1.2	0.9–1.5
IV Self-employed workers	329	46	1.2	1.1–1.4	44	1.0	0.9–1.2	26	1.2	1.0–1.5
V+VI Skilled workers	320	58	1.6	1.4–1.8	47	1.1	1.0–1.3	32	1.5	1.2–1.9
VII Unskilled workers	257	66	1.7	1.5–1.9	61	1.3	1.2–1.5	39	1.7	1.4–2.0
Physical job demands										
Walking	617	49	1	··	43	1	··	20	1	··
Sedentary work	2099	37	0.8	0.7–0.9	41	1.0	0.9–1.1	21	1.2	1.0–1.4
Walking and lifting	457	58	1.2	1.1–1.3	49	1.1	1.0–1.3	32	1.5	1.3–1.9
Heavy physical work	78	69	1.4	1.2–1.6	67	1.4	1.2–1.7	23	2.5	2.0–3.2
Job autonomy										
4 (high)	659	37	1	··	37	1	··	20	1	··
3	1893	40	1.1	1.0–1.2	41	1.1	1.0–1.3	22	1.1	0.9–1.3
2	587	53	1.4	1.2–1.6	52	1.4	1.2–1.5	27	1.3	1.1–1.6
1 (low)	112	67	1.5	1.3–1.8	70	1.6	1.3–1.8	45	1.7	1.3–2.3

[a] Unadjusted, expressed as percentages, excluding missing answers.
[b] Adjusted for age and country of birth.

Table 3. Prevalences and prevalence ratios for self-reported musculoskeletal pain according to occupational class, physical job demands, and job autonomy among the women. (95% CI = 95% confidence interval)

	N	Low-back pain			Neck–shoulder pain			Arm pain		
		Prevalence [a] (%)	Prevalence ratio [b]	95% CI	Prevalence [a] (%)	Prevalence ratio [b]	95% CI	Prevalence [a] (%)	Prevalence ratio [b]	95% CI
All women	4042	48	·	·	60	·	·	30	·	·
Occupational class										
I Higher grade professionals	709	43	1	··	59	1	··	28	1	··
II Lower grade professionals	417	42	1.0	0.9–1.1	55	0.9	0.8–1.0	30	1.1	0.9–1.3
IIIa Routine nonmanual, higher	1360	44	1.0	0.9–1.2	57	1.0	0.9–1.1	26	0.9	0.8–1.1
IIIb Routine nonmanual, lower	1111	54	1.3	1.1–1.4	65	1.1	1.0–1.2	33	1.1	1.0–1.3
IV Self-employed workers	223	50	1.2	1.0–1.4	59	1.0	0.9–1.1	29	1.0	0.8–1.3
V+VI Skilled workers	89	60	1.4	1.1–1.7	72	1.2	1.0–1.4	37	1.3	0.9–1.7
VII Unskilled workers	133	62	1.3	1.1–1.6	70	1.1	1.0–1.3	46	1.4	1.1–1.7
Physical job demands										
Walking	996	47	1	··	57	1	··	23	1	··
Sedentary work	2393	44	0.9	0.9–1.0	61	1.1	1.0–1.2	31	1.4	1.2–1.6
Walking and lifting	638	62	1.3	1.2–1.4	62	1.1	1.0–1.2	35	1.5	1.3–1.7
Heavy physical work	15	67	1.2	0.9–1.8	73	1.4	1.2–1.5	50	1.6	1.0–2.6
Job autonomy										
4 (high)	505	43	1	··	55	1	··	29	1	··
3	2261	46	1.1	1.0–1.2	59	1.1	1.0–1.2	28	1.0	0.8–1.1
2	1113	51	1.2	1.1–1.3	64	1.2	1.1–1.3	33	1.1	1.0–1.3
1 (low)	163	62	1.3	1.1–1.5	70	1.2	1.1–1.4	43	1.3	1.0–1.6

[a] Unadjusted, expressed as percentages, excluding missing answers.
[b] Adjusted for age and country of birth.

for low-back pain than for neck–shoulder pain and arm pain. The prevalence of low-back pain for the male unskilled workers was 25 percentage points higher than for the higher grade professionals, compared with a difference of 15 percentage points for the women. For neck–shoulder pain and arm pain, the corresponding

Table 4. Prevalences and prevalence differences (PD) of self-reported musculoskeletal pain among the men (N=3251). (95% CI = 95% confdence interval)

Type of pain	Prevalence (%)	Model 1 [a]		Model 2 [b]		Model 3 [c]		Model 4 [d]	
		PD	95% CI	PD	95% CI	PD	95% CI	PD	95% CI
Low-back pain									
I Higher grade professionals	35	–	..	–	..	–	..	–	..
II Lower grade professionals	33	-1	-7–4	-2	-7–4	-1	-7–4	-2	-7–4
IIIa Routine nonmanual, higher	39	5	0–10	4	-1–9	4	-1–8	3	-2–8
IIIb Routine nonmanual, lower	52	15	9–22	12	6–19	14	7–20	11	4–17
IV Self-employed workers	46	8	2–14	5	-1–11	10	4–16	7	1–13
V+VI Skilled workers	58	21	15–27	13	6–20	19	13–25	12	5–19
VII Unskilled workers	66	25	19–32	20	13–27	21	14–28	17	9–24
Neck–shoulder pain									
I Higher grade professionals	40	–	..	–	..	–	..	–	..
II Lower grade professionals	42	2	-4–7	2	-4–7	2	-3–8	2	-4–7
IIIa Routine nonmanual, higher	37	-2	-7–2	-2	-7–3	-4	-9–1	-4	-8–1
IIIb Routine nonmanual, lower	50	7	0–13	7	0–13	5	-2–11	5	-2–12
IV Self-employed workers	44	1	-5–8	1	-6–7	4	-3–10	3	-3–10
V+VI Skilled workers	47	4	-2–11	2	-5–9	2	-4–8	1	-6–8
VII Unskilled workers	61	15	8–22	14	7–21	10	3–17	10	3–17
Arm pain									
I Higher grade professionals	20	–	..	–	..	–	..	–	..
II Lower grade professionals	21	1	-4–5	–	-4–5	1	-4–6	–	-4–5
IIIa Routine nonmanual, higher	17	-2	-6–2	-1	-5–3	-2	-6–2	-1	-5–3
IIIb Routine nonmanual, lower	26	3	-2–9	4	-2–9	3	-3–8	3	-2–9
IV Self-employed workers	26	4	-2–9	3	-3–8	5	-1–10	4	-2–9
V+VI Skilled workers	32	10	5–16	8	2–14	9	4–15	7	1–13
VII Unskilled workers	39	14	7–21	13	6–20	12	5–19	11	4–18

[a] Adjusted for age and country of birth.
[b] Adjusted for variables in model 1 and physical job demands.
[c] Adjusted for variables in model 1 and job autonomy.
[d] Adjusted for variables in model 1, physical job demands, and job autonomy.

Table 5. Prevalences and prevalence differences (PD) of self-reported musculoskeletal pain among the women (N=4042). (95% CI = 95% confidence interval)

Type of pain	Prevalence (%)	Model 1 [a]		Model 2 [b]		Model 3 [c]		Model 4 [d]	
		PD	95% CI	PD	95% CI	PD	95% CI	PD	95% CI
Low back pain									
I Higher-grade professionals	43	–	..	–	..	–	..	–	..
II Lower-grade professionals	42	-1	-7–5	-1	-7–5	-1	-7–5	-1	-7–5
IIIa Routine nonmanual, higher	44	2	-3–6	0	-5–4	1	-4–5	-1	-5–4
IIIb Routine nonmanual, lower	54	11	6–16	8	3–13	9	5–14	7	2–12
IV Self-employed workers	50	7	-1–14	5	-3–12	8	0–16	6	-2–13
V+VI Skilled workers	60	16	5–27	11	0–22	15	4–25	10	-1–21
VII Unskilled workers	62	15	5–24	7	-2–17	12	3-–21	6	-4–15
Neck–shoulder pain									
I Higher-grade professionals	59	–	..	–	..	–	..	–	..
II Lower-grade professionals	55	-4	-10–2	-4	-10–2	-4	-10–2	-4	-10–2
IIIa Routine nonmanual, higher	57	-1	-6–3	0	-5–4	-2	-7–2	-1	-6–3
IIIb Routine nonmanual, lower	65	5	0–10	6	1–11	3	-2–8	4	-1–9
IV Self-employed workers	59	-1	-9–6	0	-8–7	0	-7–8	2	-6–10
V+VI Skilled workers	72	12	2–22	13	3–23	9	-1–19	10	0–20
VII Unskilled workers	70	8	-1–16	9	0–18	6	-3–15	7	-2–16
Arm pain									
I Higher-grade professionals	28	–	..	–	..	–	..	–	..
II Lower-grade professionals	30	1	-5–6	1	-4–7	1	-5–6	1	-4–6
IIIa Routine nonmanual, higher	26	-2	-6–2	-1	-5–3	-3	-7–1	-2	-6–2
IIIb Routine nonmanual, lower	33	3	-2–7	3	-1–8	1	-3–6	2	-3–6
IV Self-employed workers	29	-1	-8–6	1	-6–7	-1	-8–6	1	-6–8
V+VI Skilled workers	37	6	-4–17	7	-4–18	5	-6–15	6	-5–16
VII Unskilled workers	46	11	2–21	12	2–22	9	0–19	10	0–20

[a] Adjusted for age and country of birth.
[b] Adjusted for variables in model 1 and physical job demands.
[c] Adjusted for variables in model 1 and job autonomy.
[d] Adjusted for variables in model 1, physical job demands, and job autonomy.

differences were approximately 15 percentage points for the men and 10 percentage points for the women.

Impact of job characteristics

Adjustment for the two selected job characteristics generally reduced the prevalence differences in musculoskeletal pain between the occupational classes.

Low-back pain. For the male unskilled workers, compared with the higher grade professionals, the prevalence difference for low-back pain was reduced from 25 percentage points in model 1, to 17 percentage points in model 4 (34% reduction), and for the male skilled workers the corresponding decrease was from 21 to 12 percentage points (44%) (table 4). For the women, the corresponding reductions were from 15 to 6 percentage points (59%) for the unskilled workers and from 16 to 10 percentage points (36%) for the skilled workers (table 5). Most of the reduction occurred when physical job demands (model 2) were entered, resulting in a 22% and 38% reduction, respectively, in the two occupational classes for the men and 49% and 32%, respectively, for the women. Entering job autonomy separately (model 3) gave smaller reductions in the prevalence difference for low-back pain, approximately 10–15% for both genders.

Neck–shoulder pain and arm pain. When job characteristics were adjusted for, the prevalence difference for neck–shoulder pain among the male unskilled workers, compared with the higher grade professionals, was reduced from 15 percentage points in model 1 to 10 percentage points in model 4 (32% reduction) (table 4). For arm pain, the corresponding change was from 14 to 11 percentage points (20%). For the women the differences were smaller (table 5). Adjustment for physical job demands separately (model 2) generally increased the prevalence difference somewhat for neck–shoulder pain and arm pain among the women and resulted in only small changes among the men. However, entering job autonomy separately (model 3) gave somewhat larger reductions in the prevalence difference, 34% for neck–shoulder pain and 15% for arm pain among the male unskilled workers and 25% and 19%, respectively, among the female unskilled workers.

Population attributable fraction

Estimates of the population attributable fraction (PAF) are presented in table 6, ranging from 2% to 17% in model 1. Occupational class had a larger impact on the men than on the women for all three body regions, and the largest impact was on low-back pain (PAF estimates of 17% for the men and 10% for the women in model 1). Adjustment for physical job demands and job autonomy (model 4) reduced the PAF estimates for occupational class with respect to low-back pain, when compared with the results of model 1, both for the men (30% reduction) and for the women (50% reduction). The corresponding PAF estimate for neck–shoulder pain was reduced by 40% among the men. Adjustment for physical job demands separately (model 2) reduced the PAF estimates for occupational class in respect to all three body regions among the men, but only for low-back pain among the women (data not shown). Adjustment for job autonomy separately (model 3) reduced the PAF estimates relatively more for the women than for the men, especially for neck–shoulder pain and arm pain (data not shown).

Discussion

In this study of 7293 economically active Oslo citizens, aged 30, 40, or 45 years, there were marked, stepwise socioeconomic gradients for musculoskeletal pain, steeper for the men than for the women. The relative occupational class differences were larger for low-back pain and arm pain than for neck–shoulder pain, and the absolute differences were the largest for low-back pain. Physical job demands explained a substantial proportion of the absolute inequalities between the occupational classes for low-back pain, while job autonomy was more important in explaining the inequalities in neck–shoulder pain and arm pain. The PAF estimates supported the impact of the selected job characteristics at the level of the working population, especially for low-back pain.

Methodological considerations

The Oslo health study is a large population-based study, designed to examine socioeconomic inequalities in

Table 6. Population attributable fractions (PAF) for musculoskeletal pain according to occupational class and the impact of job characteristics. (95% CI = 95% confidence interval)

Type of pain	Men (N=3251)				Women (N=4042)			
	Model 1 [a]		Model 4 [b]		Model 1 [a]		Model 4 [b]	
	PAF (%)	95% CI	PAF (%)	95% CI	PAF (%)	95% CI	PAF (%)	95% CI
Low-back pain	17	12–22	12	7–17	10	5–15	5	0–11
Neck–shoulder pain	5	0–10	3	-2–8	2	-2–5	2	-2–5
Arm pain	12	3–20	11	1–19	3	-6–11	3	-6–12

[a] Adjusted for age and country of birth.
[b] Adjusted for the variables in model 1, physical job demands, and job autonomy.

health. All of the participants in certain age cohorts were invited, and they represented the full variety of occupations in Oslo.

The low attendance in the study could obviously have led to selection bias. This possibility has been thoroughly examined in the Oslo health study (17, 28). Søgaard et al (28) evaluated the effect of self-selection in the main survey and found that unhealthy persons seemed to attend to a less degree than healthy persons but concluded that social inequality in health by different sociodemographic variables nevertheless seemed unbiased on a ratio scale (28). Mehlum et al (17) found that the response to the supplementary questionnaire with data on musculoskeletal pain was lower in the subgroups with poorer health. This finding may imply conservative estimates of the pain prevalences and thus conservative estimates of the prevalence difference and the population attributable fraction. The consistency between the results of the Oslo health study and the survey of living conditions in 2000 from Statistics Norway, based on a representative population sample, did not, however, indicate a serious selection problem (17). Increasing nonparticipation has been a problem in many epidemiologic studies, especially in recent years, but most empirical work suggests that declines in participation rates are not likely to substantially influence exposure–disease associations (29). However, nonparticipation may influence descriptive results to a higher degree, often leading to underestimated prevalences of ill-health.

Among the 8594 respondents, data on occupation were missing for 11% of the men and 13% of the women, many of whom were not working. In Norway, 83% of the women and 90% of the men aged 30–44 years were employed in 2000–2001, and employment was somewhat higher in Oslo than in Norway as a whole, especially among the women (30). The exclusion of the economically inactive can lead to an underestimation of the socioeconomic differences in the total population (7, 31). However, the prevalences of musculoskeletal pain were almost identical in the whole population as among the participants of either gender with data on occupation, even though the participants without information on occupation generally had somewhat higher prevalences (data not shown).

The cross-sectional design of our study does not allow causal inference between our independent and outcome variables. A stronger tendency to report heavy work or low job autonomy among the participants with pain (32) cannot be ruled out. A lack of randomization in observational studies may lead to selection processes, which are particularly difficult to control in cross-sectional studies. The health-related job change of the participants with health problems, from heavier work in lower occupational classes to lighter work in higher occupational classes, would lead to conservative estimates (33), as would socioeconomic differences in the healthy worker effect, with a higher tendency towards the selection of unhealthy persons completely out of work in lower occupational classes (34).

The self-report of exposure and outcome, as in our present study, could lead to misclassification. However, in a review by Stock et al (35), questions on sitting and standing posture, walking, manual handling, and the general level of physical effort were found to perform well with respect to reproducibility and validity (35). We assume that the respondents were able to discriminate well between the crude categories employed for physical job demands and job autonomy in our questionnaire. Pain is a subjective phenomenon and cannot readily be validated. However, Björkstén et al (36) found both sensitivity and specificity to be high when questionnaire answers on musculoskeletal pain were compared with a clinical assessment.

Self-reported data on both the determinants and outcome variables could also inflate the results due to common method bias (37, 38) (eg, in relation to personality traits such as negative affectivity). The questions on job characteristics and musculoskeletal pain were, however, separated in different questionnaires, among questions on other topics. In addition, the job characteristics and musculoskeletal pain had different types of response categories. These factors may reduce common method bias due to self-report tendencies (38). In a study of musculoskeletal disorders among the general working population, Toomingas et al (39) found no support for bias from rating behavior when the participants rated both exposure and outcome (39). However, we cannot exclude the possibility that common method bias may have inflated our results.

Socioeconomic differences

Trends in socioeconomic inequalities in self-assessed health have been more stable in Norway than in some European countries, where inequalities have been widening (40, 41). Still large socioeconomic inequalities in morbidity (41) and mortality (42) remain. Aittomäki et al (10) found smaller occupational class differences in musculoskeletal disorders than in self-rated health and suggested that a fairly high prevalence of musculoskeletal disorders may explain the less steep gradient. Our present study showed a higher prevalence and a less steep gradient for neck–shoulder pain than for low-back pain among the women, while, among the men, there was both a fairly high prevalence and a relatively steep gradient for low-back pain. Musculoskeletal pain is very common in the population and may be considered a normal phenomenon (43). Nevertheless, there are socioeconomic differences.

The gradient was lower than what has been found for musculoskeletal disorders as a cause of sickness absence (11, 12, 44) or disability pension (13). Higher severity (45) and a less favorable course of pain episodes (46) in lower socioeconomic classes, in addition to occupation-specific consequences of disease (34), could explain the steeper gradients of sickness absence and disability pensioning. Our outcome measures were crude, with no differentiation between degrees of pain (severity, frequency, duration, etc). We would assume that the inequalities in severe musculoskeletal pain would be larger.

Relative and absolute measures of association may offer different inferences (23, 47, 48). We found large relative (prevalence ratio) and absolute (prevalence difference) differences for low-back pain and small differences for neck–shoulder pain. For arm pain, the prevalence ratio was large, while the prevalence difference was small. Absolute measures better express the importance of inequalities in terms of the burden of ill-health and financial costs to society (22, 47), and they may better serve as a basis for preventive strategies (48).

Impact of job characteristics

The impact of work conditions on socioeconomic inequalities in musculoskeletal pain has been shown in previous studies (9–13). In our present study, work had a relatively large impact on socioeconomic differences in musculoskeletal pain, even though job characteristics were measured by only two variables. Physical job demands were classified in rather crude categories, but the variable was still able to discriminate the risk of musculoskeletal pain. The inclusion of more job characteristics (eg, more-specific ergonomic risk factors and additional psychosocial factors) could possibly explain a larger proportion of socioeconomic inequalities in musculoskeletal pain (9).

The proportion explained by each of the job characteristics differed between the body regions. Physical job demands explained a substantial proportion of occupational class inequalities in low-back pain, while job autonomy explained a larger proportion of inequalities in neck–shoulder pain. Lifting and heavy physical work are risk factors for low-back pain, and forceful arm–hand movements may cause pain in neck–shoulders and arms (18). Specific physical exposures relevant to arm pain were not captured by our question, and this lack may explain the smaller impact of physical job demands on arm pain. High psychosocial job demands and low job control are often related to neck (49) and upper-limb (50) symptoms, but low job decision latitude (combination of job content and job control) is also a risk factor for low-back pain (51).

Population attributable fractions

In the Oslo working population, women, aged 30, 40 or 45 years, would have had a prevalence of low-back pain that was 10% lower than what was actually observed if the age groups had all had the same prevalence of low-back pain as the women in the highest occupational class. The corresponding potential reductions among the men were 17% for low-back pain and 12% for arm pain. When judged from the change in the population attributable fraction between model 1 and model 4, a substantial part of the occupational class differences in musculoskeletal low-back pain in the working population is explained by the examined job characteristics. Even if the reductions represent hypothetical cases, they give an impression of the potential for prevention at the working population level.

Gender differences

We found that the socioeconomic gradients for musculoskeletal pain were steeper among the men than among the women. This finding is in accordance with the results of some earlier studies (3, 12, 52, 53), but not with others (6, 10). Socioeconomic classification systems based on occupation were originally established for male populations and may be better at classifying men than women (54–56). The same occupational class may have different meanings for men and for women and thus be differently associated with health (57). In our study, gender differences were larger in the higher than in the lower occupational classes. Vahtera et al (12) also found that women, in contrast to men, may not benefit consistently from high socioeconomic status (12). In our present study, the women in higher occupational classes had lower job autonomy than their male counterparts (data not shown). This situation may have contributed to the smaller gradient for the women. Another explanation could be the double burden of paid and unpaid work (58), which may differ between occupational classes. Among the unskilled female workers, 36% worked part-time, compared with 11% of the higher grade professionals, but the proportion living with children under the age of 18 years was similar (data not shown).

Socioeconomic indicator

Galobardes et al (59) recommend that, for socially patterned exposures that have etiological effects specific to particular stages of the life course, socioeconomic indicators should be related to these stages (59). Occupation thus seemed a logical choice as an indicator of socioeconomic status in our study. Socioeconomic classification systems based on occupation may capture specific job-related factors (56), as was apparent in this study.

The EGP class schema does not have an implicit hierarchical rank (20), and therefore it does not necessarily capture a gradient in health across its groups (60). The self-employed group resembles the white-collar classes in terms of economic factors and social networks, while they are more similar to the working classes when physical work conditions and health behavior are studied (61). Our present study showed a pronounced gradient in musculoskeletal pain; however, the heterogeneity of the self-employed group was also apparent.

In conclusion, in this large population-based study, marked, stepwise socioeconomic gradients in self-reported musculoskeletal pain were observed in the working population, steeper for the men than for the women. Physical job demands and job autonomy explained a substantial proportion of the occupational class inequalities. As the study was cross-sectional, based on self-reported data on both determinants and outcome, the results should be interpreted with caution. However, the results indicate that interventions to reduce heavy physical work and lifting and increase job autonomy may reduce socioeconomic inequalities in the occurrence of musculoskeletal pain.

Acknowledgments

This study was supported financially by The Confederation of Norwegian Business and Industry's Working Environment Fund, Oslo, Norway, and The Directorate of Labour Inspection, Oslo, Norway. The data collection was conducted as part of the Oslo Health Study 2000–2001 in collaboration with the Norwegian Institute of Public Health.

References

1. Virtanen SV, Notkola V. Socioeconomic inequalities in cardiovascular mortality and the role of work: a register study of Finnish men. Int J Epidemiol. 2002;31:614–21.
2. Marmot MG, Bosma H, Hemingway H, Brunner E, Stansfeld S. Contribution of job control and other risk factors to social variations in coronary heart disease incidence. Lancet. 1997;350:235–9.
3. Rahkonen O, Laaksonen M, Martikainen P, Roos E, Lahelma E. Job control, job demands, or social class?: the impact of working conditions on the relation between social class and health. J Epidemiol Community Health. 2006;60:50–4.
4. Schrijvers CT, van de Mheen HD, Stronks K, Mackenbach JP. Socioeconomic inequalities in health in the working population: the contribution of working conditions. Int J Epidemiol. 1998;27:1011–8.
5. Borg V, Kristensen TS. Social class and self-rated health: can the gradient be explained by differences in life style or work environment? Soc Sci Med. 2000;51:1019–30.
6. Hemström Ö. Health inequalities by wage income in Sweden: the role of work environment. Soc Sci Med. 2005;61:637–47.
7. Molarius A, Berglund K, Eriksson C, Lambe M, Nordström E, Eriksson HG, et al. Socioeconomic conditions, lifestyle factors, and self-rated health among men and women in Sweden. Eur J Public Health. 2007;17:125–33.
8. Laaksonen M, Rahkonen O, Martikainen P, Lahelma E. Associations of psychosocial working conditions with self-rated general health and mental health among municipal employees. Int Arch Occup Environ Health. 2006;79:205–12.
9. Melchior M, Roquelaure Y, Evanoff B, Chastang JF, Ha C, Imbernon E, et al. Why are manual workers at high risk of upper limb disorders?: the role of physical work factors in a random sample of workers in France (the Pays de la Loire study). Occup Environ Med. 2006;63:754–61.
10. Aittomäki A, Lahelma E, Rahkonen O, Leino-Arjas P, Martikainen P. The contribution of musculoskeletal disorders and physical workload to socioeconomic inequalities in health. Eur J Public Health. 2006;17:145–50.
11. Melchior M, Krieger N, Kawachi I, Berkman LF, Niedhammer I, Goldberg M. Work factors and occupational class disparities in sickness absence: findings from the GAZEL cohort study. Am J Public Health. 2005;95:1206–12.
12. Vahtera J, Virtanen P, Kivimäki M, Pentti J. Workplace as an origin of health inequalities. J Epidemiol Community Health. 1999;53:399–407.
13. Hagen KB, Tambs K, Bjerkedal T. What mediates the inverse association between education and occupational disability from back pain?—a prospective cohort study from the Nord-Trøndelag health study in Norway. Soc Sci Med. 2006;63:1267–75.
14. Norwegian Institute of Public Health. The Oslo Health Study [Internet]. Oslo: Norwegian Institute of Public Health [updated June 2008, cited 22 August 2008]. Available from: http://www.fhi.no/eway/default.aspx?pid=233&trg=MainLeft_5588&MainArea_5661=5588:0:15,1869:1:0:0:::0:0&MainLeft_5588=5544:69686::1:5673:1:::0:0.
15. Holme I, Helgeland A, Hjermann I, Leren P, Lund-Larsen PG. Four-year mortality by some socioeconomic indicators: the Oslo study. J Epidemiol Community Health. 1980;34:48–52.
16. Rognerud MA, Krüger Ø, Gjertsen F, Thelle DS. Strong regional links between socio-economic background factors and disability and mortality in Oslo, Norway. Eur J Epidemiol. 1998;14:457–63.
17. Mehlum IS, Kjuus H, Veiersted KB, Wergeland E. Self-reported work-related health problems from the Oslo Health Study. Occup Med (Lond). 2006;56:371–9.
18. National Research Council, Institute of Medicine. Musculoskeletal disorders and the workplace: low-back and upper extremities. Washington (DC): National Academy Press; 2001.
19. Statistics Norway. Survey of living conditions 2000: working environment. Oslo: Statistics Norway; 2001.
20. Erikson RR, Goldthorpe JH, Portocarero L. Intergenerational class mobility in three Western European societies: England, France and Sweden. Br J Sociol. 1979;30:415–41.
21. Erikson R, Goldthorpe JH. The constant flux: a study of class mobility in industrial societies. Oxford (UK): Claredon Press; 1992.
22. Kunst A, Bos V, Mackenbach J, EU Working Group on Socioeconomic Inequalities in Health. Monitoring socio-economic inequalities in health in the European Union: guidelines and illustrations: a report for the Health Monitoring Program of the European Commission. Rotterdam (Netherlands): Department of Public Health, Erasmus University; 2001.

23. Mackenbach JP, Kunst AE. Measuring the magnitude of socio-economic inequalities in health: an overview of available measures illustrated with two examples from Europe. Soc Sci Med. 1997;44:757–71.
24. Greenland SS. Model-based estimation of relative risks and other epidemiologic measures in studies of common outcomes and in case-control studies. Am J Epidemiol. 2004;160:301–5.
25. Altman DG, Deeks JJ, Sackett DL. Odds ratios should be avoided when events are common. BMJ. 1998;317:1318.
26. Greenland S. Application of stratified analysis methods. In: Rothman KJ, Greenland S, editors. Modern epidemiology. Philadelphia (PA): Lippincott-Raven Publishers; 1998. p 281–300.
27. Eide GE. How to estimate attributable fractions in STATA: a simple introduction. Bergen (Norway): Centre for Clinical Research; 2006. Research report 4.
28. Søgaard AJ, Selmer R, Bjertness E, Thelle D. The Oslo Health Study: the impact of self-selection in a large, population-based survey. Int J Equity Health. 2004;3:3.
29. Galea S, Tracy M. Participation rates in epidemiologic studies. Ann Epidemiol. 2007;17:643–53.
30. Statistics Norway. Labour Force Survey [Internet]. Oslo: Statistics Norway [cited 22 August 2008]. Available from: www.ssb.no/arbeid_en.
31. Martikainen P, Valkonen T. Bias related to the exclusion of the economically inactive in studies on social class differences in mortality. Int J Epidemiol. 1999;28:899–904.
32. Balogh I, Ørbæk P, Ohlsson K, Nordander C, Unge J, Winkel J, et al. Self-assessed and directly measured occupational physical activities—influence of musculoskeletal complaints, age and gender. Appl Ergon. 2004;35:49–56.
33. Östlin P. Negative health selection into physically light occupations. J Epidemiol Community Health. 1988;42:152–6.
34. Brage S, Bjerkedal T, Bruusgaard D. Occupation-specific morbidity of musculoskeletal disease in Norway. Scand J Soc Med. 1997;25:50–7.
35. Stock SR, Fernandes R, Delisle A, Vézina N. Reproducibility and validity of workers' self-reports of physical work demands [review]. Scand J Work Environ Health. 2005;31(6):409–37.
36. Björkstén MG, Boquist B, Talbäck M, Edling C. The validity of reported musculoskeletal problems: a study of questionnaire answers in relation to diagnosed disorders and perception of pain. Appl Ergon. 1999;30:325–30.
37. Kristensen P. Bias from nondifferential but dependent misclassification of exposure and outcome. Epidemiology. 1992;3:210–5.
38. Podsakoff PM, MacKenzie SB, Lee JY, Podsakoff NP. Common method biases in behavioral research: a critical review of the literature and recommended remedies. J Appl Psychol. 2003;88:879–903.
39. Toomingas A, Alfredsson L, Kilbom Å. Possible bias from rating behavior when subjects rate both exposure and outcome. Scand J Work Environ Health. 1997;23(5):370–7.
40. Kunst AE, Bos V, Lahelma E, Bartley M, Lissau I, Regidor E, et al. Trends in socioeconomic inequalities in self-assessed health in 10 European countries. Int J Epidemiol. 2005;34:295–305.
41. Krokstad S, Kunst AE, Westin S. Trends in health inequalities by educational level in a Norwegian total population study. J Epidemiol Community Health. 2002;56:375–80.
42. Rognerud MA, Zahl PH. Social inequalities in mortality: changes in the relative importance of income, education and household size over a 27-year period. Eur J Public Health. 2006;6:62–8.
43. Brekke M, Hjortdahl P. Musculo-skeletal pain among 40- and 45-year olds in Oslo: differences between two socioeconomically contrasting areas, and their possible explanations. Int J Equity Health. 2004;3:10.
44. Kristensen P, Bjerkedal T, Irgens LM. Early life determinants of musculoskeletal sickness absence in a cohort of Norwegians born in 1967-1976. Soc Sci Med. 2007;64:646–55.
45. Brekke M, Hjortdahl P, Kvien TK. Severity of musculoskeletal pain: relations to socioeconomic inequality. Soc Sci Med. 2002;54:221–8.
46. Dionne CE, Von KM, Koepsell TD, Deyo RA, Barlow WE, Checkoway H. Formal education and back pain: a review. J Epidemiol Community Health. 2001;55:455–68.
47. Dahl E, Fritzell J, Lahelma E, Martikainen P, Kunst A, Mackenbach JP. Welfare state regimes and health inequalities. In: Siegrist J, Marmot M, editors. Social inequalities in health. Oxford (UK): Oxford University Press; 2006. p 193–222.
48. Lundberg O. Ojämlikhet i hälsa: definitioner, mått, mekanismer och policyimplikationer [Inequalities in health: definitions, measures, mechanisms, and policy implications]. Socialmed tidsskr. 2003;3:200–8.
49. Palmer KT, Smedley J. Work relatedness of chronic neck pain with physical findings—a systematic review. Scand J Work Environ Health. 2007;33(3):165–91.
50. Bongers PM, IJmker S, van den Heuvel S, Blatter BM. Epidemiology of work related neck and upper limb problems: psychosocial and personal risk factors (part I) and effective interventions from a bio behavioural perspective (part II). J Occup Rehabil. 2006;16:272–95.
51. Hoogendoorn WE, van Poppel MN, Bongers PM, Koes BW, Bouter LM. Systematic review of psychosocial factors at work and private life as risk factors for back pain. Spine. 2000;25:2114–25.
52. Warren JR, Hoonakker P, Carayon P, Brand J. Job characteristics as mediators in SES-health relationships. Soc Sci Med. 2004;59:1367–78.
53. Hagen KB, Holte HH, Tambs K, Bjerkedal T. Socioeconomic factors and disability retirement from back pain: a 1983-1993 population-based prospective study in Norway. Spine. 2000;25:2480–7.
54. Drever F, Doran T, Whitehead M. Exploring the relation between class, gender, and self rated general health using the new socioeconomic classification: a study using data from the 2001 census. J Epidemiol Community Health. 2004;58:590–6.
55. Mackenbach JP, Kunst AE, Cavelaars AE, Groenhof F, Geurts JJ, the EU Working Group on Socioeconomic Inequalities in Health. Socioeconomic inequalities in morbidity and mortality in western Europe. Lancet. 1997;349:1655–9.
56. Galobardes B, Lynch J, Davey Smith G. Measuring socioeconomic position in health research. Br Med Bull. 2007;81–82:21–37.
57. Arber S. Gender and class inequalities in health: understanding the differentials. In: Fox J, editor. Health inequalities in European countries. Aldershot (UK): Gower; 1989. p. 50–279.
58. Krantz G, Berntsson L, Lundberg U. Total workload, work stress and perceived symptoms in Swedish male and female white-collar employees. Eur J Public Health. 2005;15:209–14.
59. Galobardes B, Shaw M, Lawlor DA, Lynch JW, Davey Smith G. Indicators of socioeconomic position (part 1). J Epidemiol Community Health. 2006;60:7–12.
60. Galobardes B, Shaw M, Lawlor DA, Lynch JW, Davey Smith G. Indicators of socioeconomic position (part 2). J Epidemiol Community Health. 2006;60:95–101.
61. Lundberg O. Causal explanations for class inequality in health—an empirical analysis. Soc Sci Med. 1991;32:385–93.

Received for publication: 30 June 2008

III

Original article

Scand J Work Environ Health 2009;35(3):222–232

Self-reported versus expert-assessed work-relatedness of pain in the neck, shoulder, and arm

by Ingrid Sivesind Mehlum, MD,[1] Kaj Bo Veiersted, PhD,[1] Morten Wærsted, PhD,[1] Ebba Wergeland, PhD,[2] Helge Kjuus, PhD [1]

Mehlum IS, Veiersted KB, Wærsted M, Wergeland E, Kjuus H. Self-reported versus expert-assessed work-relatedness of pain in the neck, shoulder, and arm. *Scand J Work Environ Health.* 2009;35(3):222–232.

Objectives The aim of this study was to compare self-reported work-relatedness of neck–shoulder and arm pain with experts' assessments based on specific criteria.

Methods A sample of 217 employed participants in the Oslo Health Study 2000–2001, aged 30, 40, and 45 years, who reported neck–shoulder or arm pain in the past month, underwent a health examination. A criteria document for evaluating the work-relatedness of upper-extremity musculoskeletal disorders was used to establish clinical diagnoses and assess the work-relatedness of pain with respect to the subject's present job. We measured agreement between the participants and experts on whether pain was related to work as observed agreement, positive and negative specific agreement, and kappa.

Results A major proportion of the cases were assessed as work-related, somewhat more frequently by self-report than when assessed by experts (80% versus 65% for neck–shoulder pain, and 78% versus 72% for arm pain, respectively). However, there was considerable disagreement as to which cases were work-related. The experts disagreed more frequently in cases that were reported as non-work-related (particularly for neck–shoulder pain and cases reported by men). Positive specific agreement was fairly high (76–85% in the total population), while negative specific agreement was lower (37–51%). Kappa values were also low (0.16–0.34).

Conclusions Compared with expert assessment, self-reporting did not seem to particularly exaggerate work-relatedness. Nevertheless, there was considerable disagreement, especially on cases assessed as non-work-related. However, agreement will depend on the case definitions and the criteria for work-relatedness used both by the participants and the experts.

Key terms agreement; clinical diagnosis; expert-assessment; exposure; health examination; musculoskeletal disorder; occupational health; questionnaire; risk evaluation; self-assessment; upper extremity.

Self-administered questionnaires on work-related health problems are widely used, especially in population surveys (1–4), but also in more specific epidemiological studies (5–7). The validation of symptom reporting is often done when validating questionnaires (8, 9). However, self-assessment of work-relatedness has hardly been validated. Thus, although self-reported data may be easy to collect, they may be difficult to interpret as a measure of work-related illness in the population.

The definition of work-relatedness may differ according to purpose. If the aim is to prevent work-related illness, a wide definition may be preferable in order to prevent as much illness as possible (10, 11). The World Health Organization defines work-related diseases as multifactorial diseases, in which "the work environment and the performance of work contribute significantly, but as one of a number of factors to the causation" of the disease (page 9, 12). For compensation purposes, a narrower definition is commonly used (11, 13). In order to be included in the British scheduled list of prescribed occupational diseases, a disease must "more likely than not" be caused by work, defined as a (more than) doubling of risk for a person in a particular job compared to someone not in that occupation (page 9, 13).

The concept of work-relatedness may also differ among groups of people, for example, the general population versus physicians (14, 15). To our knowledge, only two studies comparing self-assessment and physician-assessment of work-relatedness have been published. Plomp (14) found hardly any relationship

1 National Institute of Occupational Health, Oslo, Norway.
2 Norwegian Labour Inspection Authority, Oslo, Norway.

Correspondence to: Dr IS Mehlum, National Institute of Occupational Health, PO Box 8149 Dep, N-0033 Oslo, Norway. [E-mail: ism@stami.no]

between Dutch occupational physicians' and employees' judgment on the work-relatedness of health problems presented during a consultation hour. The British Health and Safety Executive (15) found that the treating doctor (usually the general practitioner) largely supported his patients' assessment of work-relatedness in a survey on self-reported work-related illness. Only cases reported as work-related were studied and, in 80% of the cases in which the doctor gave an opinion, work was considered "possibly", "probably", or "definitely" a cause of the illness. The results of the two studies are thus highly divergent, and the issue needs further exploration. The Oslo Health Study provided an opportunity to compare self-reported and expert-assessed work-relatedness based on a large population sample.

Musculoskeletal disorders are the most common health problem in the general population, and the health problem most often perceived as work-related (5–7, 15). These disorders are often chronic or recurrent, and are commonly associated with hazards both at and away from work. Clinical assessment of work-relatedness may, therefore, be particularly difficult (11). However, a group of European experts (10) has developed evidence- or consensus-based criteria for evaluating the work-relatedness of upper extremity musculoskeletal disorders (MSD); these criteria have been used in epidemiological studies (16, 17) and by occupational physicians in the Netherlands (18).

In a recent study, we demonstrated high prevalences of self-reported work-related health problems in the Oslo population (5). Among 8594 subjects, 38% reported neck–shoulder pain while 20% noted pain in the elbow, forearm, or hand in the preceding month; nearly three in four reported their pain to be work-related (74% and 72%, respectively). Elsewhere, we have shown that occupational factors are important determinants of socio-economic inequalities in musculoskeletal pain in the working population of Oslo (19).

The aim of this study was to compare self-reported work-relatedness of neck–shoulder pain and arm pain with the assessments made by specialists in occupational medicine on the basis of criteria for evaluating the work-relatedness of upper extremity MSD (10).

Study population and methods

Study population

The study was part of the Oslo Health Study, a cross-sectional population study conducted from May 2000 to September 2001 under the joint collaboration of the Norwegian Institute of Public Health, the University of Oslo, and the Municipality of Oslo. All individuals in Oslo county born in 1970, 1960, 1955, 1940–41, and 1924–25 were invited by letter to attend a health screening (20). Of the three youngest cohorts (N=26 074, aged 30, 40, and 45 years), 10 712 attended the screening, and 8594 (33%) returned an age-specific supplementary questionnaire, which included questions on work-related health problems (5), similar to the questions used by Statistics Norway in regular national surveys (21).

The introductory question was: "Have you experienced any of the following common health problems in the last month, and are they totally or partially caused by working conditions in your present or previous job?" This was followed by a list of 11 commonly work-related health problems, among them *pain in neck or shoulder* and *pain in elbow, forearm, or hand* (5). The response categories were: "No, I have not experienced this"; "Yes, but not caused by work"; and "Yes, totally or partially caused by work".

To evaluate the self-reported attribution of health problems to work, 668 subjects were invited to further health examinations at the Norwegian Institute of Occupational Health (NIOH). All subjects reporting work-related eczema or respiratory symptoms were invited (N=508), 68% of whom reported pain in the neck–shoulder or arm. In addition, 160 subjects were invited on the basis of their reported neck–shoulder pain or arm pain (pain in the elbow, forearm, or hand), and were selected consecutively after attending the Oslo Health Study, at two different points in time (100 subjects reporting work-related pain and 60 subjects reporting non-work-related pain). In order to protect personal health information, the Norwegian Institute of Public Health sent the invitations to the selected subjects, informing them of our study, and asking them for consent to give their name and contact information to the NIOH. Of the 668 invited subjects, 302 gave their consent and were subsequently contacted; 268 of these were examined between September 2000 and September 2002 by one of three participating physicians in the Department of Occupational Medicine at our institute. This study was restricted to the 217 employed subjects reporting neck–shoulder or arm pain in the past month, 142 women (65%) and 75 men.

Evaluation of work-relatedness of pain

Prior to the health examination, the subjects completed a questionnaire on symptoms, occupational history, and working conditions. They answered once again the question on work-related health problems from the age-specific questionnaire of the Oslo Health Study, but with the work-related category subdivided into *present* and *previous* work. The physician checked the answers with the subject and relevant information was added. The health examination and evaluation process took

approximately one hour. The procedure for assessing the work-relatedness of pain was based on the "Criteria Document for Evaluating the Work-Relatedness of Upper-Extremity Musculoskeletal Disorders" (hereafter referred to as *the criteria document*), published by a group of European experts (10). The document's main goal is prevention; it was designed to help the physician with the process of recognizing and diagnosing work-related upper extremity MSD in the clinical setting, but certain criteria may also be used at the workplace or community level. We used the criteria document to operationalize the concept of work-relatedness and ensure a consistent assessment throughout the study.

The criteria document consists of two parts: (i) establishing the clinical diagnosis, based on case definitions and diagnostic criteria for specific disorders, and (ii) assessing the work-relatedness of the diagnosis.

Subjects reporting pain in the neck–shoulder or arm in the past month were classified as having a clinical diagnosis if the following criteria were met: (i) *temporal criteria:* symptoms present at the examination or on at least 4 days during the past 7 days, (ii) *symptom criteria* for the relevant clinical diagnoses according to the region of pain, and (iii) *sign criteria* on relevant provocative tests, thoroughly described, with photos, in the criteria document.

One of the authors of this study trained the three physicians in performing the diagnostic provocative tests. The five most common clinical diagnoses were selected for the examination: (i) radiating neck complaints, (ii) rotator cuff syndrome, (iii) epicondylitis (lateral and medial), (iv) peritendinitis–tenosynovitis in the forearm–wrist, and (v) carpal tunnel syndrome.

In accordance with the criteria document, the physicians assessed the work-relatedness of pain in all the subjects, whether or not they had a clinical diagnosis, in the following four steps, which are outlined in table 1:

Step 1*: temporal relationship*: "Did the symptoms begin, recur or worsen after the current job started?" (Yes or No);

Step 2: *occupational risk factors*: exposure to work factors known to be specifically associated with MSD in the relevant body region (neck, shoulder–upper arm, elbow–forearm, or wrist–hand), based on scientific literature or the consensus of expert groups. *Physical factors* (posture, force, movement, and vibration), and *non-physical factors* (work organizational and psychosocial factors, such as work–rest ratio, psychological demands, and social support) were categorized into three risk zones: "unacceptable" (red), "not suitable" (yellow; situations for which no green or red delineation was possible, according to the criteria document), and "acceptable" (green).

Step 3*: non-occupational risk factors*: possible non-occupational origins for the symptom, for example, rheumatic diseases, leisure injuries, exposures (physical or psychosocial) outside of work, or hobbies (Yes or No).

Step 4*: level of work-relatedness*: final decision categorized into "probably work-related" (red = take action), "possibly work-related" (yellow = plan action), and "most likely not work-related" (green = no action).

The "traffic light model" (22) focuses primarily on preventive action, and has been used in regulations and guidelines (23). This model is suitable when the evidence for some risk factors are still lacking and no single work factor or combination of work factors can be said to be the sole cause of upper extremity MSD (10).

The subjects were interviewed about the temporal relationship and the risk factors. However, their answers were carefully considered by the physician, who made the final assessment. The evaluation of occupational risk factors in step 2 was based on specific criteria for each of the four upper extremity body regions, for example: (i) movement of the hands above shoulder height during a substantial part of the day – defined as >2 hours per workday – was, according to the criteria document, a physical risk factor for the shoulder–upper

Table 1. Procedure for evaluation of work-relatedness modified from the criteria document (10). Added or modified elements in *italics*.

Step 1 (time relation)	Step 2 (occupational risk factors)	Step 3 (non-occupational risk factors)	Step 4 (level of work-relatedness)
Yes	Unacceptable (red)	Yes / no	Probably work-related (red)
Yes	Not suitable (yellow) [a]	No	Probably work-related (red)
Yes	Not suitable (yellow) [a]	Yes	Possibly work-related (yellow)
Yes	Acceptable (green)	Yes / no	*Most likely not work-related (green)*
No	Unacceptable (red)	Yes / no	Possibly work-related (yellow)
No	*Not suitable (yellow)* [a]	*No*	*Possibly work-related (yellow)*
No	*Not suitable (yellow)* [a]	*Yes*	*Most likely not work-related (green)*
No	Acceptable (green)	Yes / no	Most likely not work-related (green)

[a] "Not suitable" is, according to the criteria document, used for situations for which no green or red delineation is possible.

arm region; and (ii) having insufficient recovery time per hour when highly repetitive movements are performed was a non-physical risk factor for all four body regions. This was defined as having <10 minute break within every 60 minutes of actions performed >2–4 times/minute, or in cycles of <30 seconds (10).

In evaluating the psychosocial working conditions, we used selected scales from the General Questionnaire for Psychological and Social factors at Work (QPSNordic) (24) instead of Karasek's Job Content Questionnaire (25), which was recommended in the criteria document. QPSNordic was developed to improve the scientific quality and usefulness of questionnaires on psychosocial factors at work; it is psychometrically tested and validated in the Nordic countries (24), and extensively used in Norway. Job control was not included in the criteria document, but we found this psychosocial dimension relevant for upper extremity MSD (26, 27). We thus used scales for the three occupational factors: (i) psychological job demands (10 items), (ii) job control (9 items), and (iii) social support at work (5 items). Each item was responded to on a five-point Likert scale. Scale scores in the upper quartile for psychological job demands, and in the lower quartile for social support were considered a risk, in accordance with the criteria document, as were scores in the lower quartile of the job control scale.

The procedure of the criteria document was somewhat modified (table 1: added or modified elements in italics). Firstly, the original procedure had no category for "not suitable" (yellow) in occupational risk factors (step 2) for the alterative of "no temporal relationship" (step 1). As we soon experienced the need for this, the category was added, using the same logic as for a positive temporal relationship. Secondly, in the original procedure a positive temporal relationship (step 1), without relevant occupational risk factors (step 2), with or without non-occupational risk factors (step 3), led to the final decision of "possibly work-related" (yellow) in step 4. For example, a person with no known occupational risk factors, who had suffered a leisure injury in the upper extremity after starting his current job, and still experienced pain, would end up with a positive temporal relationship and thus be assessed as "possibly work-related". We found this unreasonable to our purpose, both in cases with and without non-occupational risk factors. We therefore modified the procedure to conclude with "most likely not work-related" in such cases.

In accordance with the criteria document, the occupational exposure (step 2) was rated "unacceptable" (red) in the presence of one or more physical risk factors for the relevant body region. If no physical risk factor was present, the occupational exposure was rated "acceptable" (green) in the absence of non-physical risk factors, and "not suitable" (yellow) when non-physical risk factors were present.

Statistical analyses

Before performing the analyses, the physicians' evaluations of risk factors were checked for inconsistencies with the criteria, without looking at the subjects' own assessments. According to the criteria document, the assessment of work-relatedness was based on the evaluation of ongoing exposure in the present job. Therefore, only pain reported caused by the present work was classified as "work-related", whereas pain reported to be caused by previous work (N=22) was classified as "non-work-related". The fact that the latter group was comparable to the strict "non-work-related" group (N=18), particularly on occupational risk factors for upper extremity MSD according to the criteria document, supported this classification. The study participants thus had two response categories: "work-related" and "not work-related", while the physicians had three: "probably work-related", "possibly work-related", and "most likely not work-related". Comparisons were made, with the physicians' "probably work-related" and "possibly work-related" categories combined as "work-related", as well as with the "possibly work-related" category omitted. We measured the agreement between subjects and physicians as observed agreement (ie, simple or raw agreement: the proportion of cases for which the raters agree), and positive and negative specific agreement (ie, the proportion of cases in a category, positive or negative, for which the raters agree), and calculated kappa (ie, chance-corrected agreement) (28). See the appendix for details. Analyses were performed using the statistical software SPSS 15.0 for Windows (SPSS Inc, Chicago, IL, USA).

The study protocol was approved by the Norwegian Data Inspectorate and recommended by the Regional Committee for Medical Research Ethics.

Results

Self-reported work-relatedness of pain

The presence of self-reported neck–shoulder pain and arm pain overlapped considerably among the 217 subjects (table 2). Nearly all reported neck–shoulder pain (N=208), while arm pain was somewhat less frequent (N=150), and almost two in three reported both (N=141). Work-related pain in at least one region was reported by 177 subjects (hereafter called the work-related group), while 40 subjects did not report any work-related pain (the non-work-related group). Subjects in the latter group were somewhat older and more frequently had a part-time job than subjects in the work-related group (table 3). Part-time work was more common among women than among men (18% versus 5%), but the proportion of women was similar in both groups.

The prevalence of region-specific physical risk factors for upper extremity MSD, according to the criteria document, was substantially higher in the work-related than in the non-work-related group, in particular risk factors for arm pain (table 3). Undertaking computer or mouse work most of the workday, and repetitive work with insufficient recovery time were somewhat more frequent in the work-related group. Differences in psychosocial working conditions were generally small. However, although the prevalence of high psychological demands was similar, the average level was higher in the work-related than in the non-work-related group (3.1 versus 2.8; range 1–5).

In both groups, approximately one in three had one or more clinical musculoskeletal diagnoses (table 3). Long duration of pain was more frequent in the non-work-related group; 38% had pain lasting at least 15 years, compared to 18% among subjects reporting work-related pain. However, the latter group more often had co-workers with similar pain, and their pain improved much during vacations. There were minor differences with regard to the consequences of pain (table 3), except that subjects in the non-work-related group more frequently had changed their work. However, 10 of the 12 subjects with non-work-related pain who had changed their work, reported that their pain was caused by a previous job.

Within the work-related group, subjects who reported work-related pain in both the neck–shoulder and arm regions (N=107) differed somewhat from subjects who reported work-related neck–shoulder, but no arm, pain (N=52). The former group more frequently had physical risk factors in their work; 64% versus 45% had physical risk factors for neck pain, and 47% versus 24% had risk factors for shoulder pain. Computer or mouse work and repetitive work with insufficient recovery time were also more frequent (38% versus 21%, and 25% versus 10%, respectively). However, high psychological job demands seemed to be more frequent among subjects who reported work-related pain only in the neck–shoulder region (12% versus 4%).

Of the 217 subjects, 120 reported eczema (80 work-related) and 96 reported respiratory symptoms (30 work-related). Perceived work-relatedness of these symptoms was more frequent in the work-related than in the non-work-related group: 41% versus 18% for eczema, and 15% versus 8% for respiratory symptoms.

Table 2. Distribution of subjects according to self-reported region and work-relatedness of pain, attributed to the present job.

Neck–shoulder	Arm			Total
	Work-related pain	Non-work-related pain	No pain	
Work-related pain	107	8	52	167
Non-work-related pain	4	22	15	41
No pain	6	3	0	9
Total	117	33	67	217

Table 3. Background, exposure, and outcome-related variables among subjects with neck–shoulder or arm pain, according to self-reported work-relatedness in the present job. (% is valid percent)

	Work-related pain (N_1=177)		Non-work-related pain (N_2=40)	
	N	%	N	%
Gender				
Women	118	67	24	60
Men	59	33	16	40
Age				
30 years	55	31	8	20
40 years	65	37	12	30
45 years	57	32	20	50
Work				
Full-time	159	90	29	72
Part-time	18	10	11	28
Presence of physical risk factors (≥1) based on criteria document	126	71	13	33
Physical risk factors for:				
Neck pain (N_1=165, N_2=35) [a]	93	56	11	31
Shoulder/upper arm pain (N_1=158, N_2=31) [a]	61	39	6	19
Elbow/forearm pain (N_1=90, N_2=20) [a]	61	68	5	25
Wrist/hand pain (N_1=113, N_2=22) [a]	81	72	7	32
Computer or mouse work >4 hours per workday	55	31	8	20
Repetitive work with insufficient recovery time	35	20	3	8
Poor psychosocial working conditions (≥1 factors)	43	24	10	25
High psychological demands	10	6	2	5
Low decision latitude	32	18	6	15
Low social support	5	3	3	8
Clinical diagnoses (≥1)	69	39	12	30
Radiating neck complaints	19	11	6	15
Rotator cuff syndrome	41	23	5	13
Epicondylitis	17	10	2	5
Peritendinitis/tenosynovitis in forearm/wrist	12	7	2	5
Carpal tunnel syndrome	21	12	6	15
Much better on days off	32	18	3	8
Much better during vacations	96	55	10	26
Co-workers with similar pain	95	54	13	33
Consequences of pain				
Reduced workability (very much/quite a lot)	55	31	13	33
Reduced leisure time activity (very much/quite a lot)	53	30	16	40
Medical consultation (past year)	78	44	14	35
Sickness certification (past year)	42	24	11	28
Change of job because of pain	19	11	12	31

[a] Subjects with pain in the specific region.

Self-reported versus expert-assessment

Among the 208 subjects with neck–shoulder pain, 167 (80%) reported their pain to be work-related, while the experts assessed 136 cases (65%) to be probably or possibly work-related (table 4). However, there was considerable disagreement as to which cases were work-related. Of the 167 cases reported by participants as work-related, the experts assessed 51 (31%) to be not work-related. Of the 41 cases self-reported as not work-related, the experts assessed 20 (49%) to be probably or possibly work-related; this was higher in men (79%) than in women (33%). However, the numbers are small, particularly in men.

Among the 150 subjects with arm pain, 117 (78%) reported work-related pain, while the experts assessed 108 cases (72%) to be probably or possibly work-related (table 5). There was somewhat less disagreement as to which cases were work-related than for neck–shoulder pain. Of the 117 cases reported as work-related, the experts assessed 24 (21%) to be non-work-related. Of the 33 cases reported as non-work-related, the experts assessed 15 (45%) to be probably or possibly work-related – 58% in men and 39% in women.

The agreement between self-reported and expert-assessed work-relatedness was generally higher for arm pain than for neck–shoulder pain (table 6). The positive specific agreement was 74–88%, while the negative was much lower, generally 37–52%, but particularly low for neck–shoulder pain in men, which was approximately 20%. Kappa values were fairly low, ranging between -0.02–0.37, and lowest for neck–shoulder pain in men, for whom the agreement was no better than chance. When we included the "possibly work-related" category, compared with excluding it, the observed agreement and the positive specific agreement increased, while the negative specific agreement and the kappa value decreased. Among subjects with clinical diagnoses, all agreement measures were higher, with kappa values of 0.33 and

Table 4. Self-reported and expert-assessed work-relatedness of *neck–shoulder pain* among women and men and in the total population.

		Expert-assessed					
		Probably work-related		Possibly work-related		Not work-related	
Self-reported	N	N	%	N	%	N	%
Women							
Work-related	112	62	55	12	11	38	34
Not work-related	27	6	22	3	11	18	67
Total	139	68	49	15	11	56	40
Men							
Work-related	55	37	67	5	9	13	24
Not work-related	14	7	50	4	29	3	21
Total	69	44	64	9	13	16	23
Total population							
Work-related	167	99	59	17	10	51	31
Not work-related	41	13	32	7	17	21	51
Total	**208**	**112**	**54**	**24**	**12**	**72**	**35**

Table 5. Self-reported and expert-assessed work-relatedness of *arm pain* among women and men and in the total population.

		Expert-assessed					
		Probably work-related		Possibly work-related		Not work-related	
Self-reported	N	N	%	N	%	N	%
Women							
Work-related	74	44	59	12	16	18	24
Not work-related	21	6	29	2	10	13	62
Total	95	50	53	14	15	31	33
Men							
Work-related	43	33	77	4	9	6	14
Not work-related	12	4	33	3	25	5	42
Total	55	37	67	7	13	11	20
Total population							
Work-related	117	77	66	16	14	24	21
Not work-related	33	10	30	5	15	18	55
Total	150	87	58	21	14	42	28

Table 6. Agreement measures comparing self-reported and expert-assessed work-relatedness of neck–shoulder pain and arm pain among women (N=142) and men (N=75), and in the total population (N=217).

	Neck–shoulder pain		Arm pain	
	Possibly/ probably work-related [a] (%)	Probably work-related [b] (%)	Possibly/ probably work-related [c] (%)	Probably work-related [d] (%)
Women				
Observed agreement	66	58	73	60
Positive specific agreement	77	74	82	79
Negative specific agreement	43	45	50	52
Men				
Observed agreement	65	58	76	69
Positive specific agreement	81	79	88	87
Negative specific agreement	20	23	43	50
Total population				
Observed agreement	66	58	74	63
Positive specific agreement	78	76	85	82
Negative specific agreement	37	40	48	51

[a] Kappa = 0.23 for women, -0.02 for men and 0.16 for total population.
[b] Kappa = 0.25 for women, 0.03 for men and 0.19 for total population.
[c] Kappa = 0.32 for women, 0.29 for men and 0.31 for total population.
[d] Kappa = 0.32 for women, 0.37 for men and 0.34 for total population.

Table 7. Differences in expert-assessed work-relatedness of neck–shoulder pain and arm pain between using the modified and the original procedure of the criteria document.

	Expert-assessed			
	Possibly work-related		Not work-related	
Self-reported	Modified procedure	Original procedure	Modified procedure	Original procedure
Neck–shoulder pain				
Work-related	17	54	51	14
Not work-related	7	14	21	14
Total	24	68	72	28
Arm pain				
Work-related	16	32	24	8
Not work-related	5	12	18	11
Total	21	44	42	19

0.42 for neck–shoulder pain (N=60) and arm pain (N=27) respectively, excluding the "possibly work-related" category.

Table 7 shows the differences in the experts' assessment of work-relatedness when using the modified versus the original procedure of the criteria document. As the modification did not influence the "probably work-related" category, this was omitted from the table. If we had used the original procedure, 44 additional cases of neck–shoulder pain would have been assessed as possibly work-related (68 versus 24) instead of non-work-related. The corresponding additional cases of arm pain would have been 23 (44 versus 21). This would have given somewhat higher agreement measures, with kappa values of 0.29 versus 0.16 for neck–shoulder pain including the "possibly work-related" category, and 0.39 versus 0.19 when excluding the category (data not shown). For arm pain, the corresponding kappa values would have been 0.31 (same value) and 0.45 versus 0.34, respectively.

Discussion

Our comparative study included 217 Oslo citizens (aged 30, 40 and 45 years) who reported neck–shoulder pain or arm pain in the past month. A major proportion of these cases were assessed as work-related, although somewhat more frequently by the subjects than by the experts. However, there was considerable disagreement as to which cases were work-related. There was more agreement on arm pain than neck–shoulder pain and generally more on cases assessed as work-related, as opposed to non-work-related ones, particularly in men.

Methodological considerations

The low participation in the Oslo Health Study may have led to self-selection of healthy individuals into the study. This would primarily have influenced the descriptive results, and has been thoroughly discussed elsewhere (5, 29). There were twice as many women as men among the subjects in our study, which may partly be explained by the facts that neck–shoulder pain and arm pain are more prevalent among women, and that women to a larger extent participated in the Oslo Health Study (5).

Thirty-four subjects consented to be contacted but were not examined, mainly because their symptoms were better or because they did not want an examination. The proportion of self-reported work-related cases was somewhat higher in our study than in the Oslo Health Study; 91% versus 74% for neck–shoulder pain and 90% versus 72% for arm pain, including cases caused by a previous job. However, we will not assume that self-selection of individuals with work-related pain significantly influenced comparisons between work-related and non-work-related pain, or between self-reported versus expert-assessed work-relatedness. The low attendance, particularly of subjects reporting non-work-related pain, led to small numbers in the stratified analyses, and thus uncertain results. The physicians were not blind to the subjects' assessments, which is a precondition for the measures of agreement employed. Employing formalized criteria for work-relatedness and checking for inconsistencies with the criteria without looking at the subjects' own assessments, may have reduced the interdependence of the two assessments. Subjects provided information on exposure which was evaluated by experienced physicians in occupational medicine. Objective exposure data are recommended by some, especially in cases of claims for financial compensation or legal issues (30). We share the view held by others that self-reported ergonomic exposures, in general, are adequate for epidemiologic purposes (31), and sufficiently accurate for our purpose.

Several factors may influence the attribution of illness to work, for example beliefs about disease etiology, a need to find an external explanation for symptoms, or a potential for economic compensation (14, 32). The subjects in our study had nothing to gain or to lose by attending the health examination, or reporting their pain as work-related or non-work-related. With the exception of hand-arm vibration syndrome, MSD are not eligible for compensation in Norway. The participating experts were independent of all stakeholders such as employers, employees/patients or insurance bodies (32), and met the subjects only once in relation to the research project.

Results

Negative specific agreement and kappa values were generally low, with the latter below 0.40, often defined as poor/slight (<0.21) to fair (0.21–0.40) agreement (33, 34). However, our sample was unbalanced, with low prevalences of non-work-related pain assessed by both subjects and experts. A severely unbalanced sample may lead to low kappa and low specific agreement in the rare category (28, 35, 36).

If our sample (208 with neck–shoulder pain, 150 with arm pain) had been perfectly balanced, with an equal number of self-reported work-related and non-work-related cases, and with the same percentage distribution of the experts' assessments as in the real sample, the kappa values would have been somewhat higher; 0.28 versus 0.19 for neck–shoulder pain and 0.42 versus 0.34 for arm pain, excluding the "possibly work-related" category. The corresponding values for negative specific agreement would have been substantially higher, 63% versus 40% and 68% versus 51%, respectively. Thus, our unbalanced sample may have contributed to the fairly low agreement between the subjects and the experts.

The experts assessed as non-work-related quite a few conditions reported by the subjects as work-related. However, the experts assessed, as probably or possibly work-related, a larger proportion of conditions reported to be not work-related, especially in men. The positive specific agreement was thus higher than the negative, reflecting higher agreement on work-related than non-work-related cases. This result is noteworthy, as one might anticipate self-report of work-relatedness to lead to overestimation rather than underestimation, compared with the experts' assessments. Both may, however, reflect differences between the experts' perspective and the lay perspective of the causes of illness (14). It is also worth keeping in mind that there is no "gold standard" in these cases.

We found higher agreement for arm pain than for neck–shoulder pain. The former may be more closely related to physical risk factors, and the latter to psychosocial factors, as indicated by our results, while the criteria document emphasizes physical risk factors more than psychosocial ones.

In our study, the experts disagreed more with men than women who reported their neck–shoulder pain as non-work-related. Men may be unaware of a possible connection between their work and pain, they may hesitate to report their pain as work-related, or they may see their pain as an inevitable part of their job, and consequently not worth reporting (37). On the other hand, reporting of work-related pain, with which the experts disagreed, was somewhat more frequent in women than in men. Force-demanding tasks have been found to be considerably more strenuous for females than males, which may explain excess musculoskeletal morbidity among females (38). Workplace design factors may be an important reason for gender differences in working technique (39). In our study, physical risk factors for upper extremity MSD, according to the criteria document, were somewhat more frequent in men (73% had one or more) than in women (59%). However, the criteria do not differentiate according to gender, and may thus underestimate the risk in women. In addition, a higher total workload in paid and unpaid work among women (39) may make them more vulnerable to lower levels of physical work exposure.

Subjects reporting work-related pain were somewhat younger than those reporting non-work-related pain, but age did not seem to be a consistent predictor of agreement between responder and expert (data not shown). Among subjects with clinical diagnoses, all agreement measures were higher. These subjects had positive provocative tests, in addition to their symptoms, and may represent a group with more serious pain conditions, for whom the association between work and pain was more evident to both the individual and the expert. Subjects reporting work-related eczema or respiratory symptoms more frequently reported work-related pain also, but did not seem to exaggerate the work-relatedness of their pain (higher positive specific agreement; data not shown).

Eight individuals had encountered occupational injuries which still caused pain in the upper extremity region; seven of them reported their pain as work-related in the present job. Such cases are not captured by the criteria document, but may reasonably be considered as work-related. For these subjects, changing the final decision to the "probably work-related" category only marginally changed the agreement values.

Work-relatedness

Subjects who reported work-related pain had substantially higher prevalences of physical risk factors for upper extremity MSD in their work than those reporting non-work-related pain (table 3). Physical risk factors form a major part of the criteria for evaluation of work-relatedness, and the differences in these between the self-reported work-related and non-work-related groups may be considered a separate measure of agreement.

A temporal relationship, with exposure before response, is essential in causal inference (40) and is considered a sine qua non for assuming causality (36). It was also considered important by the subjects, but not without exception; approximately 20% of the women and 15% of the men who reported work-related pain, did not report a positive time relationship (data not

shown). On the other hand, approximately 85% of the subjects who did report such a relationship, assessed their pain to be work-related.

The concept of work-relatedness may differ according to context or purpose. Plomp (14) found somewhat higher agreement between occupational physicians and employees when the consultation was initiated by the physician (eg, because of absenteeism or a periodical medical examination) rather than the employee. He suggested that the potential socio-economic implications of the label of "work-relatedness of health problems" might be important, such as loss of job, reduction in income, or dispensation from specific types of work. An occupational physician, being salaried by the employer, may have a different position in relation to the employee/patient than a general practitioner. This may in part explain the different results found by Plomp (hardly any agreement) and by the British Health and Safety Executive (largely supportive of their patients' assessment) (15). Besides, differences in experience between occupational physicians and general practitioners, with respect to evaluation of work-relatedness, may lead to differences in assessments (42).

Our study's participants and the experts did not use the same response categories. The "possibly work-related" category gave the experts an extra, less certain alternative, which the subjects did not have. On the other hand, the subjects were asked whether their pain was "totally or partially caused by working conditions", while the criteria document was based on evidence or consensus of a causal relation. Lower levels of work exposure, below the risk levels of the criteria, may not cause pain in healthy individuals or those with low exposure outside their work. They may, however, lead to an exacerbation of a pre-existing condition, the development of pain in an individual with a high total workload in paid and unpaid work (39), or the maintenance or recurrence of pain in subjects with work-related pain caused by a previous high risk job. Such cases would be assessed as work-related by the subject but non-work-related by the experts – correctly according to our criteria. Thus, the somewhat different criteria and response alternatives may have resulted in lower agreement in our study.

According to the procedure of the original criteria document, a positive time relationship, without relevant occupational risk factors, would lead to the final decision of a case being possibly work-related. This procedure would have resulted in considerably more cases being assessed as possibly work-related (table 7) and higher agreement values. The original procedure may capture some cases caused or made worse by exposure levels lower than the risk levels of the criteria, particularly in vulnerable individuals. According to the criteria document, further investigation of the "possibly work-related" cases is warranted (eg, observation of the work situation, or surveillance of the person over time) (10). This was beyond the scope of our study. We chose to modify the procedure of the criteria document to suit our needs. However, the original procedure may be reasonable when the purpose of the evaluation is the prevention of upper extremity MSD and further investigation is possible.

Using criteria in the assessment of work-relatedness may reduce subjectivity in judgments. However, we often found it difficult to evaluate exposures in work against the criteria, in particular repetitiveness in occupations with some degree of repetitive work, but not assembly work. We discussed this matter with the authors of the criteria document and found our judgments needed to be stricter. As a consequence, fewer cases were assessed as work-related. Others may have encountered the same problem. While 54% of neck–shoulder pain conditions and 58% of arm pain conditions were assessed as probably work-related in our study, 95% of upper extremity MSD cases in men and 89% in women (<50 years), were classified as such in a study by Roquelaure et al (16), in which the criteria document was used. This may indicate discrepancies in the application of the criteria document and the need for further improvement and specification of the criteria.

Concluding remarks

Self-reported data is often used to follow population trends in work-related illness. Self-assessed work-relatedness of disease has been found to be an independent predictor of work disability (43), and may thus be of importance as such. However, the use of these data as a measure of work-related illness in the population has often been considered with skepticism, assuming it would result in exaggerated estimates. The British Health and Safety Executive (15) performed a case review to identify and exclude cases which were clearly not work-related, and concluded that their prevalence estimates based on self-reported work-related diseases could be reduced by 24%. However, they did not evaluate cases reported as non-work-related to adjust for potential under-reporting.

Our results indicate that prevalence estimates based on self-report may be more valid than previously assumed with regard to neck–shoulder pain and arm pain. Compared with the assessment of experts, self-reporting did not seem to particularly exaggerate work-relatedness. However, there was considerable disagreement between the subjects and experts in individual cases. Agreement was higher for cases assessed as work-related compared to those categorized as non-work-related, and higher for arm pain than for neck–shoulder pain. Studies of other disease categories (15), or other age or cultural groups may yield different results, and need to be performed.

Several factors, in addition to true disagreement, contributed to low agreement values, including an unbalanced sample and different response categories for subjects and experts.

Agreement will depend on the criteria by which the subjects and the experts evaluate work-relatedness. When we included the cases assessed by the experts to be possibly work-related in our analyses, the agreement values changed (compared to excluding such cases); this was also the case when using the modified procedure of the criteria document as opposed to the original. Both might influence to what extent cases made worse by work are included as work-related. Agreement will also depend on the case definition, illustrated by higher agreement for clinical diagnoses than for all cases of self-reported pain. The fact that a large proportion of reported non-work-related cases were attributed to a previous job, raises the issue that, with a wider definition, most cases of neck–shoulder and arm pain might actually be considered as work-related.

Acknowledgements

This study was supported financially by The Confederation of Norwegian Business and Industry's Working Environment Fund (Oslo, Norway) and The Directorate of Labour Inspection (Oslo, Norway). The primary data collection was conducted as part of the Oslo Health Study 2000–2001 in collaboration with the Norwegian Institute of Public Health, which also administered the invitations to the subjects selected for our study. We would like to thank Helge Jansson, MD, for examining 18 of the included subjects while working at the NIOH, and members of the Veiersted family (Janne, Andreas, and Julie), for entering the data.

References

1. Statistics Norway. Level of living survey 2006: work conditions. Oslo: Statistics Norway; 2007.
2. Tynes T, Eiken T, Grimsrud TK, Sterud T, Aasnæss S. Arbeidsmiljø og helse – slik norske yrkesaktive opplever det: resultater fra Statistisk sentralbyrås levekårsundersøkelse for 2006 [Work environment and health – as experienced by working Norwegians: results from the Level of living survey 2006 from Statistics Norway]. Oslo: National Institute of Occupational Health; 2008. STAMI-rapport, number 16.
3. Parent-Thirion A, Fernández Macías E, Hurley J, Vermeylen G. Fourth European Working Conditions Survey. Dublin: European Foundation for the Improvement of Living and Working Conditions; 2007.
4. Health and Safety Executive (HSE). Self-reported work-related illness and workplace injuries in 2006–07: results from the Labour Force Survey. Caerphilly (United Kingdom): HSE; 2008.
5. Mehlum IS, Kjuus H, Veiersted KB, Wergeland E. Self-reported work-related health problems from the Oslo Health Study. Occup Med (Lond). 2006;56:371–9.
6. Räsänen K, Notkola V, Husman K. Perceived work conditions and work-related symptoms among employed Finns. Soc Sci Med. 1997;45:1099–110.
7. Thorslund M, Wärneryd B, Östlin P. The work-relatedness of disease: workers' own assessment. Sociol Health Illn. 1992;14:57–72.
8. Perreault N, Brisson C, Dionne C, Montreuil S, Punnett L. Agreement between a self-administered questionnaire on musculoskeletal disorders of the neck-shoulder region and a physical examination. BMC Musculoskeletal Disorders 2008;9:34.
9. Torén K, Brisman J, Järvholm B. Asthma and asthma-like symptoms in adults assessed by questionnaires. A literature review. Chest 1993;104:600-8.
10. Sluiter JK, Rest KM, Frings-Dresen MHW. Criteria document for evaluating the work-relatedness of upper-extremity musculoskeletal disorders. Scand J Work Environ Health. 2001;27 suppl 1:1–102.
11. Chen Y, Agius R, McNamee R, Turner S, Taylor S, Fulluck L, et al. Physicians' beliefs in the assessment of work attribution when reporting musculoskeletal disorders. Occup Med (Lond). 2005;55:298–307.
12. World Health Organization (WHO). Identification and control of work-related diseases: report of a WHO Expert Committee. Geneva: WHO; 1985. Technical Report Series, number 714.
13. Department for Work and Pensions (DWP). Completion of the review of the scheduled list of prescribed diseases: report by the Industrial Injuries Advisory Council in accordance with Section 171 of the Social Security Administration Act 1992 marking the completion of the review of the scheduled list of prescribed diseases. London: DWP; 2007.
14. Plomp HN. Employees' and occupational physicians' different perceptions of the work-relatedness of health problems: a critical point in an effective consultation process. Occup Med (Lond). 1993;43 suppl 1:S18–S22.
15. Jones JR, Hodgson JT, Clegg TA, Elliott RC. Self-reported work-related illness in 1995: results from a household survey. Norwich (United Kingdom): Her Majesty's Stationery Office; 1998.
16. Roquelaure Y, Ha C, Leclerc A, Touranchet A, Sauteron M, Melchior M, et al. Epidemiologic surveillance of upper-extremity musculoskeletal disorders in the working population. Arthritis Rheum. 2006;55:765–78.
17. Melchior M, Roquelaure Y, Evanoff B, Chastang JF, Ha C, Imbernon E, et al. Why are manual workers at high risk of upper limb disorders? The role of physical work factors in a random sample of workers in France (the Pays de la Loire study). Occup Environ Med. 2006;63:754–61.
18. Spreeuwers D, Pal T, van der Laan G, editors. Signaleringsrapport Beroepsziekten '07 [Alert report on occupational diseases '07]. Amsterdam: Dutch Center for Occupational diseases,

Coronel Institute of Occupational Health, Academic Medical Center, University of Amsterdam; 2007.
19. Mehlum IS, Kristensen P, Kjuus H, Wergeland E. Are occupational factors important determinants of socioeconomic inequalities in musculoskeletal pain? Scand J Work Environ Health. 2008;34(4):250–9.
20. Norwegian Institute of Public Health. The Oslo Health Study [Internet]. Oslo: Norwegian Institute of Public Health [updated June 2008, cited 18 December 2008]. Available from: http://www.fhi.no/eway/default.aspx?pid=238&trg=MainLeft_5853&MainArea_5811=5853:0:15,2818:1:0:0:::0:0&MainLeft_5853=5825:54464::1:5857:4:::0:0
21. Statistics Norway. Survey of living conditions 2000: working environment. Oslo: Statistics Norway; 2001.
22. Andersen V, Bjurvald M, editors. Vägar till färre arbetsskador – utveckling av nordisk ergonomitillsyn, modeller för ergonomisk riskvärdering [How to reduce work injuries – development of Nordic ergonomic labour inspection, models for ergonomic risk assessment]. Copenhagen: Nordic Council of Ministers; 1994. TemaNord 1994:514.
23. Norwegian Labour Inspection Authority. Veiledning til forskrift om tungt og ensformig arbeid [Guidlines to the regulations on heavy and monotonous work]. Trondheim: Norwegian Labour Inspection Authority; 1995.
24 Dallner M, Elo AL, Gamberale F, Hottinen V, Knardahl S, Lindström K, et al. Validation of the General Nordic Questionnaire (QPSNordic) for psychological and social factors at work. Copenhagen: Nordic Council of Ministers; 2000. Nord 2000:12.
25. Karasek R. Job demands, job decision latitude and mental strain: implications for job redesign. Adm Sci Q. 1979;24:285–308.
26. Palmer KT, Smedley J. Work relatedness of chronic neck pain with physical findings – a systematic review. Scand J Work Environ Health. 2007;33(3):165–91.
27. Ariëns GA, van Mechelen W, Bongers PM, Bouter LM, van der Wal G. Psychosocial risk factors for neck pain: a systematic review. Am J Ind Med. 2001;39:180–93.
28. Hripcsak G, Heitjan DF. Measuring agreement in medical informatics reliability studies. J Biomed Inform. 2002;35:99–110.
29. Søgaard AJ, Selmer R, Bjertness E, Thelle D. The Oslo Health Study: the impact of self-selection in a large, population-based survey. Int J Equity Health. 2004;3:3.
30. Kuiper JI, Burdorf A, Frings-Dresen MH, Kuijer PP, Spreeuwers D, Lötters FJ et al. Assessing the work-relatedness of nonspecific low-back pain. Scand J Work Environ Health 2005;31(3):237-43.
31. Punnett L, Wegman DH. Work-related musculoskeletal disorders: the epidemiologic evidence and the debate. J Electromyogr Kinesiol 2004;14:13-23.
32. Dembe AE. Occupation and disease: how social factors affect the conception of work-related disorders. New Haven (CT): Yale University Press; 1996.
33. Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics. 1977;33:159–74.
34. Altman DG. Practical statistics for medical research. London: Chapman and Hall; 1991. p 403–9.
35. Feinstein AR, Cicchetti DV. High agreement but low kappa: I. The problems of two paradoxes. J Clin Epidemiol. 1990;43:543–9.
36. Cicchetti DV, Feinstein AR. High agreement but low kappa: II. Resolving the paradoxes. J Clin Epidemiol. 1990;43:551–8.
37. Pransky G, Snyder T, Dembe A, Himmelstein J. Under-reporting of work-related disorders in the workplace: a case study and review of the literature. Ergonomics 1999;42:171-82.
38. Nordander C, Ohlsson K, Balogh I, Hansson GÅ, Axmon A, Persson R, et al. Gender differences in workers with identical repetitive industrial tasks: exposure and musculoskeletal disorders. Int Arch Occup Environ Health. 2008;81:939–47.
39. Dahlberg R, Karlqvist L, Bildt C, Nykvist K. Do work technique and musculoskeletal symptoms differ between men and women performing the same type of work tasks? Appl Ergon. 2004;35:521–9.
40. Hill AB. The environment and disease: association or causation? Proc R Soc Med. 1965;58:295–300.
41. Rothman KJ, Greenland S, Poole C, Lash TL. Causation and causal inference. In: Rothman KJ, Greenland S, Lash TL, editors. Modern epidemiology. 3rd ed. Philadelphia (PA): Lippincott, Williams & Wilkins; 2008. p 5–31.
42. O'Neill E, McNamee R, Agius R, Gittins M, Hussey L, Turner S. The validity and reliability of diagnoses of work-related mental ill-health. Occup Environ Med. 2008;65:726–31.
43. Martimo KP, Varonen H, Husman K, Viikari-Juntura E. Factors associated with self-assessed work ability. Occup Med (Lond). 2007;57:380–2.

Received for publication: 22 December 2008

Appendix : Definition of agreement measures (28,36)

	Rater B		
Rater A	Pos	Neg	Total
Positive	a	b	g_1
Negative	c	d	g_2
Total	f_1	f_2	N

Observed agreement = $\frac{a + d}{N}$

Positive specific agreement = $\frac{a}{\frac{f_1 + g_1}{2}} = \frac{2a}{2a + b + c}$

Negative specific agreement = $\frac{2d}{b + c + 2d}$

Appendix I

14 Appendix I: HUBRO questions

14.1 Questions from the HUBRO questionnaires, in Norwegian

14.1.1 Spørsmål fra Tilleggsskjema I (30 og 45 år) og II (40 år)

ARBEIDSFORHOLD OG HELSE

Forhold på arbeidsplassen (arbeidsmiljø, jobbkrav) kan iblant gi helseproblemer.

Har du i løpet av den siste måneden hatt noen av disse vanlige helseproblemene, og kan de helt eller delvis skyldes arbeidsforhold i din nåværende eller i tidligere jobber?

(Sett ett kryss for hver linje)	**Nei, har ikke hatt dette**	**Ja, men skyldes ikke jobb**	**Ja, skyldes helt eller delvis jobb**
Øyeplager med kløe, sårhet, rødhet eller rennende øyne ……	☐	☐	☐
Neseplager med tetthet, nysing eller rennende nese……	☐	☐	☐
Tetthet i brystet, piping i brystet……	☐	☐	☐
Tung pust ved gange i bakker eller trapper……	☐	☐	☐
Eksem, hudkløe, utslett……	☐	☐	☐
Dårlig hørsel……	☐	☐	☐
Smerter i nakke, skuldre……	☐	☐	☐
Smerter i albue, underarm, hånd……	☐	☐	☐
Smerter i nedre del av ryggen, korsryggen……	☐	☐	☐
Tretthet eller matthet utenom det vanlige……	☐	☐	☐
Søvnproblemer, innsovningsvansker……	☐	☐	☐

14.1.2 Spørsmål fra Hovedtilleggsskjema

T1. SKOLEGANG/STUDIER OG ARBEID

1.3	**Hvis du er i lønnet eller ulønnet arbeid, hvordan vil du beskrive ditt arbeid?** *(Sett bare ett kryss)*	
	For det meste stillesittende arbeid?…… *(f.eks. skrivebordsarbeid, montering)*	☐
	Arbeid som krever at du går mye?…… *(f.eks. ekspeditørarb., lett industriarb., undervisning)*	☐
	Arbeid hvor du går og løfter mye?…… *(f.eks. postbud, pleier, bygningsarbeid)*	☐
	Tungt kroppsarbeid?…… *(f.eks. skogsarb., tungt jordbruksarb., tungt bygn.arb.)*	☐

1.4	**Kan du selv bestemme hvordan arbeidet ditt skal legges opp?** *(Sett bare ett kryss)*	
	Nei, ikke i det hele tatt	☐
	I liten grad	☐
	Ja, stort sett	☐
	Ja, det bestemmer jeg selv	☐

14.2 Questions from the HUBRO questionnaires, English translation

14.2.1 Questions from the Second supplementary questionnaires I (30 and 45 years) and II (40 years)

WORKING CONDITIONS AND HEALTH

Working conditions (work environment, job demands) may sometimes lead to health problems.

Have you experienced any of the following common health problems in the last month, and are they totally or partially caused by working conditions in your present or previous job?

(One cross for each line)	**No, I have not experienced this**	**Yes, but not caused by work**	**Yes, totally or partially caused by work**
Eye symptoms with itchiness, soreness, redness or watering eyes	☐	☐	☐
Nose symptoms with stuffiness, sneezing or running nose	☐	☐	☐
Chest tightness, wheezing	☐	☐	☐
Heavy breathing when walking up hills or climbing stairs	☐	☐	☐
Eczema, itching skin, skin rash	☐	☐	☐
Impaired hearing	☐	☐	☐
Pain in neck or shoulders	☐	☐	☐
Pain in elbow, forearm, hand	☐	☐	☐
Low back pain	☐	☐	☐
Extraordinary tiredness or fatigue	☐	☐	☐
Sleep disturbance, problems falling asleep	☐	☐	☐

14.2.2 Questions from the First supplementary questionnaire

T1. SCHOOLING/STUDIES AND WORK		
1.3	**If you have paid work or do unpaid work, how would you describe your work?** *(One cross only)*	
	Mainly sedentary work?..... *(e.g. desk work, assembly work)*	☐
	Work involving a lot of walking?..... *(e.g. shop assistant, light industrial work, teaching)*	☐
	Work involving a lot of walking and lifting?..... *(e.g. post delivery, caring work, building and construction work)*	☐
	Heavy physical work?..... *(e.g. forestry work, heavy agricultural work, heavy building and construction)*	☐
1.4	**Can you yourself decide how your work should be organised?** *(One cross only)*	
	No, not at all.....	☐
	To a small degree.....	☐
	Yes, largely.....	☐
	Yes, I decide myself.....	☐

Appendix II

15 Appendix II: Criteria document risk factors

15.1 Quantification of parameters used in the criteria for work-relatedness

Somewhat adapted from the criteria document (59)

Qualitative descriptor of parameter	Quantification or unit used in the criteria
Extreme posture	Over half of ROM[1] of a joint with respect to the movement of interest, present regularly during the workday
High repetitiveness	Actions performed more than 2 to 4 times a minute, or cycles less than 30 seconds
Most of the day	Movements or postures performed for more than a total of 4 hours per workday
Substantial part of the day	For more than a total of 2 hours per workday
High force	Hand weights of more than 4 kg
Too little recovery time	Less than 10-minute break possible within every 60 minutes that highly repetitive movements are performed
High psychological job demands	Scale score higher than 75 % of the maximum score
Low job control [2]	Scale score lower than 25 % of the maximum score
Low social support	Scale score lower than 25 % of the maximum score

[1] ROM = range of movement

[2] Not included in the criteria document

15.2 Physical risk factors

1. Neck

Posture during a workday

- Holding the chin opposite the breast bone during most of the day (extreme neck flexion)
- Sitting work during most of the day with static postures of the neck and upper extremity and without rest pauses
- Unsupported arms when work with the upper extremity is performed during most of the day

Movement during a workday

- Highly repetitive neck extension movements during most of the day
- Highly repetitive extreme neck flexion movements during most of the day
- Highly repetitive upper extremity movements performed during most of the day

2. Shoulder and upper arm

Posture during a workday

- Holding the hand behind the trunk (extension) during a substantial part of the day movements are performed
- Holding the hand before the opposite side of the trunk (extreme adduction) during a substantial part of the day
- Holding the shoulder in extreme outward rotation during a substantial part of the day
- Holding an unsupported arm away from the body for a couple of minutes during a substantial part of the day

Movement during a workday

- Moving the hands above shoulder height during a substantial part of the day
- Highly repetitive upper extremity movements during most of the day
- Combination of factors during a workday
- Applying high force with the aforementioned repetitive movements and posture

3. Elbow and forearm

Posture during a workday

- Holding the hand close to the upper body during a substantial part of the day (extreme elbow flexion)
- Holding the elbow fully extended during a substantial part of the day
- Holding the forearm in an extreme twisted position during a substantial part of the day (pronation or supination)

Movement during a workday

- Highly repetitive elbow and wrist movements during most of the day

Force during a workday

- High forceful work for forearm muscles during a substantial part of the day (eg, squeezing or pinching objects or hand-tools with the hands)

Combination of factors during a workday

- Combination of the aforementioned posture, repetition, and force

For elbow osteoarthrosis

- Exposure to vibrating hand-tools during more than a total of 1 hour per workday

4. Wrist-hand

Posture during a workday

- Holding the wrist in extreme postures during a substantial part of the day
- Holding tools or objects in a pinch or grip position during most of the day

Movement during a workday

- Highly repetitive movements of wrist-hand or fingers during most of the day

Force during a workday

- High exertion by the hand(s) during a substantial part of the day (eg, mediated by use of hand-tools)

Combination of factors during a workday

- Combination of the aforementioned posture, repetition, and force
- Computer or mouse work during most of the day

For wrist-finger osteoarthrosis, carpal tunnel syndrome and vibration white fingers and hand-arm vibration syndrome

- Exposure to vibrating hand-tools during more than a total of 1 hour during the workday

For vibration white finger

- Cold work environment during most of the day (not evaluated in the study)

15.3 Non-physical factors

All four body regions

Work–rest ratio during a workday

- Too little recovery time per hour when highly repetitive movements are performed

Work characteristics in period before complaints started

- High psychological job demands
- Low job control
- Low social support

15.4 Selected questions from the General Questionnaire for Psychological and Social factors at Work (QPS$_{Nordic}$)

Psychological job demands	very seldom or never	rather seldom	some-times	rather often	very often or always
1. Is your work load irregular so that the work piles up?	1	2	3	4	5
2. Do you have to work overtime?	1	2	3	4	5
3. Is it necessary to work at a rapid pace?	1	2	3	4	5
4. Do you have too much to do?	1	2	3	4	5
5. Does your work require quick decisions?	1	2	3	4	5
6. Are your work tasks too difficult for you?	1	2	3	4	5
7. Does your work require maximum attention?	1	2	3	4	5
8. Does your work require complex decisions?	1	2	3	4	5
9. Do you perform work tasks for which you need more training	1	2	3	4	5
10. Does your job require that you acquire new knowledge and new skills?	1	2	3	4	5
Job control	very seldom or never	rather seldom	some-times	rather often	very often or always
1. If there are alternative methods for doing your work, can you choose which method to use?	1	2	3	4	5
2. Can you influence the amount of work assigned to you?	1	2	3	4	5
3. Can you set your own work pace?	1	2	3	4	5
4. Can you decide yourself when you are going to take a break?	1	2	3	4	5
5. Can you decide the length of your break?	1	2	3	4	5
6. Can you set your own working hours (flexitime)?	1	2	3	4	5
7. Can you influence decisions concerning the persons you will need to collaborate with?	1	2	3	4	5
8. Can you decide when to be in contact with clients?	1	2	3	4	5
9. Can you influence decisions that are important for your work?	1	2	3	4	5

Social support at work	very seldom or never	rather seldom	some-times	rather often	very often or always
1. If needed, can you get support and help with your work from your co-workers?	1	2	3	4	5
2. If needed, can you get support and help with your work from your immediate superior?	1	2	3	4	5
3. If needed, are your co-workers willing to listen to your work-related problems?	1	2	3	4	5
4. If needed, is your immediate superior willing to listen to your work-related problems?	1	2	3	4	5
5. Are your work achievements appreciated by your immediate superior?	1	2	3	4	5