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A quarter century perspective on low back pain

– A longitudinal study

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List of papers

This thesis is based on the following papers, which will be referred to as study 1-5 in the text.

Paper 1
Bildt Thorbjörnsson CO, Alfredsson L, Fredriksson K, Köster M, Michélsen H, Vingård E, Torgén M, Kilbom Å. (1998) Psychosocial and physical risk factors associated with low back pain: A 24-year follow-up among women and men in a broad range of occupations. *Occupational and Environmental Medicine 55*:84-90

Paper 2
Bildt Thorbjörnsson C, Michélsen H, Kilbom Å. (1999) Method for retrospective collecting of work-related psychosocial risk factors for musculoskeletal disorders: Reliability and aggregation. *Journal of Occupational Health Psychology In press*

Paper 3
Bildt Thorbjörnsson C, Alfredsson L, Fredriksson K, Michélsen H, Punnett L, Vingård E, Torgén M, Kilbom Å. (1999) Physical and psychosocial factors related to low back pain during a 24-year period: A nested case control analysis. *Spine In press*

Paper 4
Bildt Thorbjörnsson C, Alfredsson L, Michélsen H, Punnett L, Vingård E, Torgén M, Öhman A, Kilbom Å. (1999) Occupational and non-occupational risk indicators for incident and chronic low back pain in a sample of the Swedish general population during a four-year period: An influence from depression? *Submitted* to International Journal of Behavioral Medicine

Paper 5
Bildt Thorbjörnsson C, Alfredsson L, Teobald H, Punnett L, Torgén M, Wikman A. (1999) Effects from attrition in a longitudinal study of musculoskeletal disorders. *Submitted* to Scandinavian Journal of Work, Environment & Health 1999

Abbreviations used in this thesis

LBP	low back pain
ILBP	incident low back pain
CLBP	chronic low back pain
PR	prevalence ratio
CIR	cumulative incidence ratio
OR	odds ratio
c.i.	confidence intervals

Contents

Introduction

Low back pain has been defined in various ways, but most definitions include pain from the lumbar spine region, a certain minimum duration and/or frequency of pain, and debilitating consequences of the symptoms (Leboeuf-Yde & Lauritzen 1995). Clinically most symptoms are self-reported, and may often be hard to corroborate with objective tests (Cailliet 1996). However, chronic low back pain may often result from degeneration of the disc (Chaffin & Andersson 1991). Low back pain is often recurrent, and one of the strongest predictors for low back pain is earlier episodes of low back pain (Biering-Sørensen 1983). Pain in the lower back often induces constriction of movement, and can seriously afflict daily life for stricken individuals. Persistent pain also influences the psychological well-being of the individual (Esbjörnsson 1991). Traditionally, the physiological aspects of low back pain have been in focus, but in later years the psychological aspects have been given more consideration, both in research and in rehabilitation efforts.

In the general population, low back pain is a common problem. The lifetime incidence of low back pain in the Danish general population was found to be 61-80 percent among women and men in different occupations (Biering-Sørensen 1983). In an earlier population study the lifetime incidence rates of low back pain were reported to be 51-80 percent (Abrahamson, Terespolsky & Brook 1965), and in the general population low back pain is most common among persons about 40 years of age. In contrast to other musculoskeletal disorders, the prevalence and lifetime incidence of low back pain do not differ between the genders, although it seems that men have their first episode of low back pain earlier in life than women, and that the genders differ in the response to low back pain (Linton 1998). In a Swedish study, it was shown that women sought medical care to a higher degree than men, whereas men required sick-leave more often than women, when the pain was at its worst

Analyses of potential occupational risk factors for low back pain usually takes into account either physical factors only, or psychosocial factors only. Less often, both types of factors have been simultaneously studied and analyzed (Heliövaara, Mäkelä & Knekt 1991; Leino & Hänninen 1995), and even less frequently, conditions outside work have been studied in parallel with work-related conditions (Barnekow-Bergkvist et al 1998; Feurstein, Sult & Houle 1985; Josephson 1999). Such a parallel approach is necessary for an understanding of the relative significance of different occupational and non-occupational risk factors. For example, for women, but not for men, mainly routine job and job strain increased the probability of reporting a high physical workload at work (Josephson 1999). An important argument for using this approach is that, especially among women, a large part of the total daily physical and psychosocial load derives from activities outside of work (Frankenhauser 1991; Josephson

1999; Lundberg, Mårdberg & Frankenhauser 1994). For women, it has been shown that being gainfully employed and spending many hours per week working with household tasks increases the likelihood of seeking medical care because of low back pain (Josephson 1999). In relation to this, it is important to study women and men.

A second argument is that there might be interactions between work-related factors and conditions outside work, especially for factors of a psychosocial nature. Such factors might influence each other, as suggested by both Frankenhauser (1991) and Friedman (1992). Such reciprocal influences complicate analyses of associations between work-related psychosocial risk factors and health outcomes, but increase the need of analyses that include several different data domains.

To better understand the causality of low back pain, a longitudinal approach is needed. However, longitudinal studies are both time-consuming and expensive, and therefore analysis of retrospective data may provide a valuable alternative.

The scope of this thesis

This thesis is primarily focused on epidemiological studies of low back pain. However, the approach is broader than what is common in this field of research because of the need to assess many aspects of the individual's life situation (Magnusson 1998). The primary objective was to analyze associations between occupational and non-occupational conditions and low back pain. Many methodological questions are relevant in this field of research, and methodological aspects of assessment of information about psychosocial conditions at work, as well as of consequences of attrition in longitudinal studies, will also be examined. Special emphasis in this thesis has been on gender differences in which occupational and non-occupational risk factors were associated with low back pain and on interactive effects on low back pain from various occupational and non-occupational conditions.

Conditions that influence low back pain

Even in a very schematic model, the complexity of the relations between various conditions and musculoskeletal symptoms is apparent (figure 1). Interactions between many of the included factors are very likely to occur, as are loops. In figure 1, not all possible two-way directions are marked, and no loops are indicated. In the present thesis, the data collected can be categorized into the boxes 1, 3, 4, 5, 7 and 9. These boxes will be referred to in the text as "box X".

Incident and chronic low back pain

Although low back pain is common in the general population, the problems have various duration and intensity for different individuals and at different times in life. Many occupational and non-occupational conditions, described below,

influence the onset and the duration of low back pain. Common categorizations of low back pain are incident (or acute) (box 3) and chronic (box 4) low back pain.

Individual characteristics

In agreement with clinical observations, personality traits have been suggested as maintaining factors for chronic low back pain (box 4) (Esbjörnsson 1991; Gentry 1972). Personality traits (included in box 9) that have been mentioned in these circumstances are Type-A behavior, negative affectivity and lack of social competence. Also psychological disorders (included in box 9), especially depression, have been related to chronic low back pain (Esbjörnsson 1991; Gentry 1972). Studies focusing on depression in patients with chronic low back pain have reported a prevalence three or four times higher than that found in the general population (Sullivan et al 1992). Persistent pain has been shown to afflict the individual and influence mood, personality functioning and adaptive capacity (Esbjörn-sson 1991). Anxiety and worries can often be seen in individuals with acute pain, and depression is common among individuals with long-lasting pain.

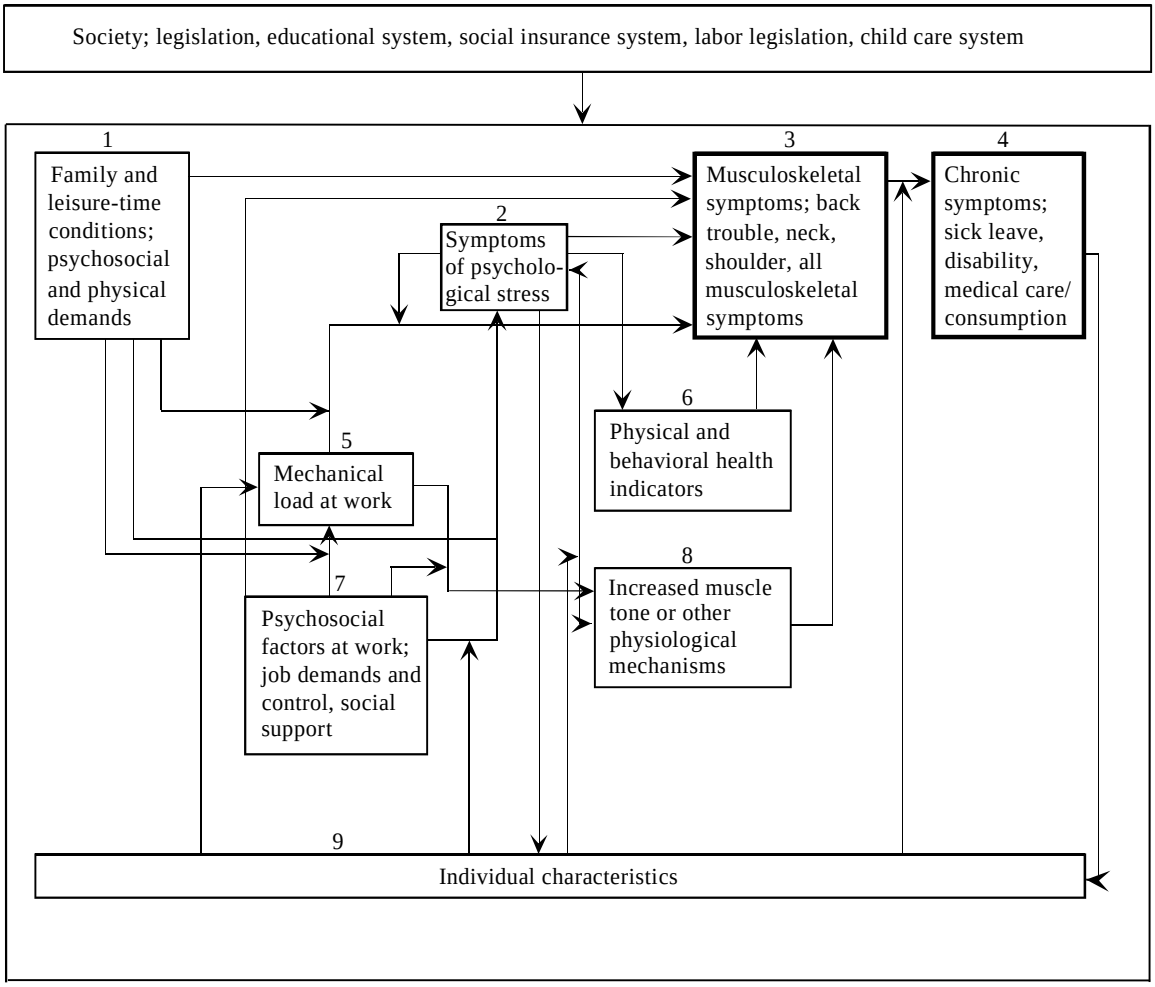

Figure 1. Possible directions of the relations between various factors and musculo-skeletal symptoms

Several possible models of causality between occupational and non-occupational conditions, incident low back pain, chronic low back pain, and depression can be sketched. Depression (included in box 9) may be causing low back pain through mechanisms similar to those activated by psychosocial factors at work and outside work, and inversely, low back pain may be causing depression. Functional disability, rather than pain intensity, has been shown to predict depressive symptoms among male low back pain patients (Epping-Jordan et al 1998). It has been proposed that chronic pain and depression have certain common pathogenic mechanisms, for example personality traits and low levels of melatonin and high levels of endorphin (von Knorring & Ekselius 1994). Depression has also been proposed to contribute to chronic pain syndromes, through increased sensitivity to pain by an influence on the hormonal activity (Kilbom et al 1996). Associations found between depression and low back pain probably occur through an effect-modifying relationship.

For depression, mostly non-occupational factors have been examined as potential risk factors (Bildt Thorbjörnsson 1998). However, occupational factors predicting depression in longitudinal studies include for example time pressure, high mental demands, job stress, shift work, few opportunities to influence working situation, high physical load and piecework (Bildt Thorbjörnsson 1998; Bildt Thorbjörnsson & Kilbom 1998; Reifman, Biernat & Lang 1991, Schonfeld & Ruan 1991; Schonfeld 1992).

Occupational conditions

Psychosocial working conditions (box 7) include the individual's experience of the contents and organization of work, as well as of the social relations at work. Psychosocial factors that appear to be reliably associated with low back pain are monotonous work, time pressure, poor job satisfaction and lack of control in the working situation (Burdorf 1997; Frank et al 1996a; Vingård 1999). Several hypotheses about how psychosocial factors may affect the musculoskeletal system have been proposed. Psychosocial occupational factors have been assumed to be involved in the development of low back pain either directly, or by increasing the effect of psychological stress (box 2) or mechanical load (box 5) on tissues (Bernard 1997, p. 7-1 to 7-10; Theorell 1996). Several possible pathways for this have been suggested. A high level of psychological stress for example will lead to tense muscles, resulting in more vulnerable muscle tissues (Bernard 1997, p. 7-1 to 7-10; Waddell et al 1993). Another possible mechanism may be sensitized mechanoreceptors, leading to skin contacts being experienced as painful (Cohen, Arrouo, Champion & Browne 1992). Catabolic processes within the muscle have also been suggested as a possible mechanism for development of low back pain (Theorell 1996). Initial episodes of low back pain elicited by a mechanical load trigger (box 5) may induce a chronic dysfunction of the nervous system (box 3), with associated chronic pain process (box 4) (Bernard 1997, p. 7-1 to 7-10; Bongers et al 1993). Thus, associations found between psychosocial occupational

factors and low back pain may occur either through a causal or an effect-modifying relationship.

The physical work environment, i.e. mechanical load (box 5), is the most studied part of the working conditions in relation to low back pain. Physical risk factors reliably associated with low back pain are heavy lifting, awkward trunk postures, vehicle driving and whole body vibrations (Frank et al 1996a; Vingård 1999). Physical occupational risk factors may result in low back pain through several mechanisms. High physical load (box 5) can cause damage in muscle tissues (box 3), and as can lighter physical load if it is of long duration and there are few breaks (figure 1) (Sjögaard 1998; Hägg, Suurkula & Kilbom 1990). Static load (box 5) leads to increased intra-muscular pressure (box 8), and may result in disturbed circulation, disturbed metabolism, pain or inflammatory processes (box 3). Both inter- and intra-muscular processes are involved, as are both the peripheral and the central nervous system (Johansson & Sojka 1991; Sjögaard 1998). The muscles in the lower back are responsible for both stability and motion of the torso (Riihimäki 1998). Sudden overexertion, or sustained or repetitive load, can cause fatigue in muscles and ligaments in the lower back, resulting in low back pain. The inter-vertebral disks can degenerate as a part of the normal aging process and break when exposed to high mechanical loads such as in bending, twisting and handling loads. Associations found between physical occupational factors and low back pain probably occur through a causal relationship.

Non-occupational conditions

Demanding non-occupational conditions (box 1) include the actual psychosocial and physical demands on the individual from children, elderly relatives and household tasks. The family chores are, in general, more burdensome for females than for males (Josephson 1999; Lundberg et al 1994). Non-occupational physical load has, for example, been shown to be related to low back pain (Mundt, Kelsey & Golden 1993). Other factors included in non-occupational conditions are poor social support (instrumental as well as emotional), conflicts with family members or friends, lack of time for own interests and lack of time for physical and psychological recuperation after work. Non-occupational conditions like these have seldom been analyzed as potential risk factors for low back pain, but other non-occupational factors, such as poor coping strategies, have been analyzed and seem to have a stronger maintaining effect than occupational factors have on chronic low back pain (Frank et al 1996b). Non-occupational factors, such as physical load outside work and poor social support from friends and family are likely to affect the muscles in a way similar to the occupational factors (Theorell 1996). Thus, associations found between non-occupational conditions and low back pain may occur either through a causal or an effect-modifying relationship.

Societal context of this thesis

Society has changed profoundly since the base-line examination in the present thesis, and it is of value to understand how the Swedish society has developed during the studied time period and also how gender segregated the Swedish labor market is.

Changes in educational levels and in working conditions in the Swedish society during 1975-1995

This thesis includes studies of exposure and outcome data from 1969 to 1997, nearly three decades. During these years, large changes in labor participation and in educational levels among women and men in the Swedish society have taken place. Many of these changes can be examined by using the official statistics from Statistics Sweden. Since 1975, annual surveys of living conditions ("ULF") have been performed and published by Statistics Sweden. The results of the surveys during 1975-1995 have been published in one volume (including one cd-rom) (Statistics Sweden 1997). The following descriptions of changes during 1975-1990 are based on this information.

The educational level in the population has changed to a large degree during these years. Among the women between 24-44 years of age (younger women) the proportion with upper secondary education had increased from 32 percent to 41 percent, and among men in the same age group from 23 percent to 40 percent. In the older age groups (45-64 years of age), the proportions had increased from 23 percent to 35 percent among women and from 17 to 27 percent among men. The increase in college or university education follows the same pattern, with about 13 percent of both genders in the two age groups having a university education in 1995.

The proportion of gainfully employed younger women has changed from 75 percent to 81 percent during 1975-1995 with a peak in the late eighties, and among the older women from 65 percent to 79 percent. Among men in the two age groups, the corresponding numbers are 95 percent and 86 percent, and 87 percent and 83 percent, in the two age groups. The numbers of hours per week during which a person is exposed to demanding occupational working conditions (box 5 and 7) are in general higher among men than among women, even though the mean working time has increased from about 30 hours to 34 hours per week among women during this time period. The mean working time has been about 40 hours per week for men during the whole period. The unemployment rate has increased from 2 percent to 11 percent among the youngest age groups of both genders, and from to 5 percent among women and 2 percent among men to 7 percent in the older age groups.

The working conditions have changed very much during these years, with a decreased proportion of women and men reporting such "traditional" occupational risk factors as work in noisy (about 5 percent among women and about 12 percent among men) and dirty environment (about 3 percent among women and about 18 percent among men). An increase in reports of heavy lifting (box 5) could be

observed among younger women, from about 18 percent to 27 percent, as could a decrease of heavy lifting from 22 percent to about 17 percent among the older men.

The perceived health status has changed to the better among the oldest age groups, with about 61 percent among women and 66 percent among men who consider their health to be good. Among the younger age groups, this trend cannot be seen; but more women and men in these age groups than in the older groups consider themselves to be of good health (82% of the women and 86% of the men).

The gender segregated Swedish labor market

The labor market in Sweden, as in other countries, is strictly gender segregated (Westberg 1998). Typical female occupations (more than 75% female employees) are secretary, day care assistant, nurse, home help assistant, pre-school teacher, kitchen assistant and cleaner. Typical male occupations (more than 75% male employees) are building and construction work, driver, engineer, architect, motor and machine repairman, manufacturing mechanic, sales, and system designer/ programmer. Only ten percent of the employees in Sweden work in non-segregated occupations (between 40% and 60% of each gender). In 1997, 62 percent of the employed women and 90 percent of the employed men worked full time, i.e. more than 35 hours per week (Westberg 1998). Thus, part time work is much more common among women then among men. There are also significant differences between the tasks women and men perform within most occupations in Sweden and elsewhere (Westberg 1998; Evans 1987; Messing & Kilbom 1998). Work tasks performed by women tend to be more stationary, have short series, be repetitive and require less training (and they also pay less). Also in occupations with higher status, as in the medical profession, women and men tend to specialize in different areas. These differences in working conditions lead to women and men experiencing different problems related to the work environment.

Methodological considerations

Several methodological questions may be of interest in studies like the ones included in the present thesis. All methods of data collection have their problems, which can have consequences on the quality of the collected data, and on the reliability and validity of the results obtained in the studies. In epidemiological studies, bias because of misclassification of exposure or outcome can occur, as can bias because of selection effects (Rothman & Greenland 1998). These biases can be differential – for example if the individuals with low back pain more accurately than the healthy individuals are classified as highly exposed to heavy lifting – or non-differential (where the misclassification of exposure is unrelated to low back pain, or vice versa). The influence from differential biases can influence the ratio estimates in both directions in the studies, depending on the direction of the bias. Non-differential biases influence the ratio estimates towards null. In this thesis, two methodological complexes are considered.

Various ways of collecting data about previous conditions

Studies using retrospective information of exposure and/or outcome have relied on various sources of information. Often, information collected for other reasons and stored in medical records has been used to get at exposure and/or outcome data (Arnetz et al 1987; Fredriksson et al 1998a; Fredriksson et al 1998b; Mannon et al 1994; Nyström et al 1990; Orhagen & d'Elia 1992; Raschmann, Patterson & Scofield 1990). Other common sources of information about earlier conditions are retrospectively collected information on exposure and/or outcome, either through questionnaires or through interviews (Ashton 1991; Cheng & Rogers 1989; John & Gibbs 1982; Moser et al 1996; Stockwell et al 1984; Svensson & Andersson 1989). In studies using mortality as the outcome measure, relatives may be asked to answer questionnaires or are interviewed about the habits of the deceased person (Lloyd et al 1986; Pickles et al 1994). When the working conditions providing the exposures of interest have proven stable over time, generalizations from the current situation can safely be made (Moen et al 1995). Some studies have used combinations of these different methods of collecting retrospective data (Bailey, Nothanagel & Wolfe 1995; Melamed 1993; O'Gorman 1982).

Potential sources of bias in epidemiological studies

Differences in characteristics between the dropouts and the participants may cause serious bias in an epidemiological study. To be a source of bias, differences in exposure conditions among participants and dropouts – and such are often found – must be related to the studied outcome (Criqui 1979). Such a systematic bias may lead to under- or over-estimation of the ratio estimates found in epidemiological studies. When differences between participants and dropouts are found, for example in educational levels, these may indicate differences in both exposure conditions and health status, thereby influencing the results in the study. The attrition rate in large studies of musculoskeletal disorders during the last ten years has ranged between 7 and 57 percent, mostly between 14 and 33 percent (Bergenudd & Nilsson 1988; Bigos et al 1991; Boshuizen, Hulshof & Bongers 1990; Kurppa et al 1991; Pietri-Taleb et al 1995; Riihiimäki et al 1994; Schibye et al 1995; Veiersted & Westgaard 1994; Viikari-Juntura et al 1991; Viikari-Juntura et al 1994). There are not, to the best of our knowledge, any detailed studies of differences in characteristics between dropouts and participants, and of possible consequences arising from these differences. The attrition rate is (with a few exceptions) reported, and possible consequences are discussed in a tentative manner.

Present disorders or symptoms can affect the subject's ability to accurately recall earlier or present conditions (Rothman & Greenland 1998). Ongoing pain in the lower back can, hypothetically, result in systematic recall bias by enhancing the low back pain case's ability to accurately recall earlier and present physical demands at work (as has been shown) (Köster et al 1999), or by leading to over-reports of such demands.

In collecting data retrospectively, the influence of memory and later experiences on the recalled information must be taken into account. This has been studied particularly in investigations of economic conditions, self-reported health problems and in studies of attitudes (Magnusson & Bergman 1990). In studies of life events, the curve of forgetting, as in experimental studies of the psychology of memory, is highly dependent on the method of definition of the areas of events, the method of inquiry and the techniques of evaluation (Haffner, Moschel & ten Horn 1987). Memories of a particular situation are therefore not stable from one occasion to another. Experiences gained before the event influence the way in which the event is perceived, and thus also how it is recalled (Strube, 1987). Low frequency of occurrence of an event is important because it facilitates recall and the temporal location of the event (Carroll & Mayer 1986). It has also been shown that events with high emotional content is better recalled, even at more distant times, than less emotionally loaded events (Haffner et al 1987). These studies concerns mainly factors influencing recall ability and recall biases in general, but little is know about factors influencing recall ability and recall biases when studying work-related conditions.

Aims and hypothesis

The main aims in the present thesis were to identify occupational and non-occupational risk indicators for low back pain among women and men; to examine potential interaction effects between these occupational and non-occupational conditions; to develop and evaluate methods for retrospective assessment of psychosocial working conditions; and to study the effect of attrition on the ratio estimates in the analyses of association.

In study 1, the main aim was to examine the long-term predictive value of occupational and non-occupational conditions in 1969 for low back pain during 1969-1993. Another aim was to study interactive effects on low back pain from occupational and non-occupational factors.

In study 2, the aim was to develop and evaluate a method for retrospective assessment of psychosocial working conditions.

The aim in study 3 was to examine the predictive value of retrospectively assessed occupational and non-occupational conditions during 1970-1993 for retrospectively assessed low back pain during the same period. Further aims were to study the time relation between reports of various occupational and non-occupational conditions and occurrence of low back pain, and to study potential interactions between physical and psychosocial factors at work as well as between occupational and non-occupational conditions and their effects on low back pain.

In study 4, the aims were to add depression to the analyses of association between occupational and non-occupational conditions and incident and chronic low back pain, and to study potential differences in risk indicators for incident and chronic low back pain.

The aims in study 5 were to examine potential differences between the study participants and the dropouts, and to analyze the effect of these differences on the ratio estimates.

Methods

Study context

The present thesis is a part of a large research program, Work after 45, started in 1990 at the National Institute for Working Life. The aim was to contribute to a work design that benefits health, personal development, commitment and productivity among the elderly. This aim was to be achieved through multidisciplinary research in work organization, ergonomics, physiology, psychology and occupational medicine.

Participants and main outlines

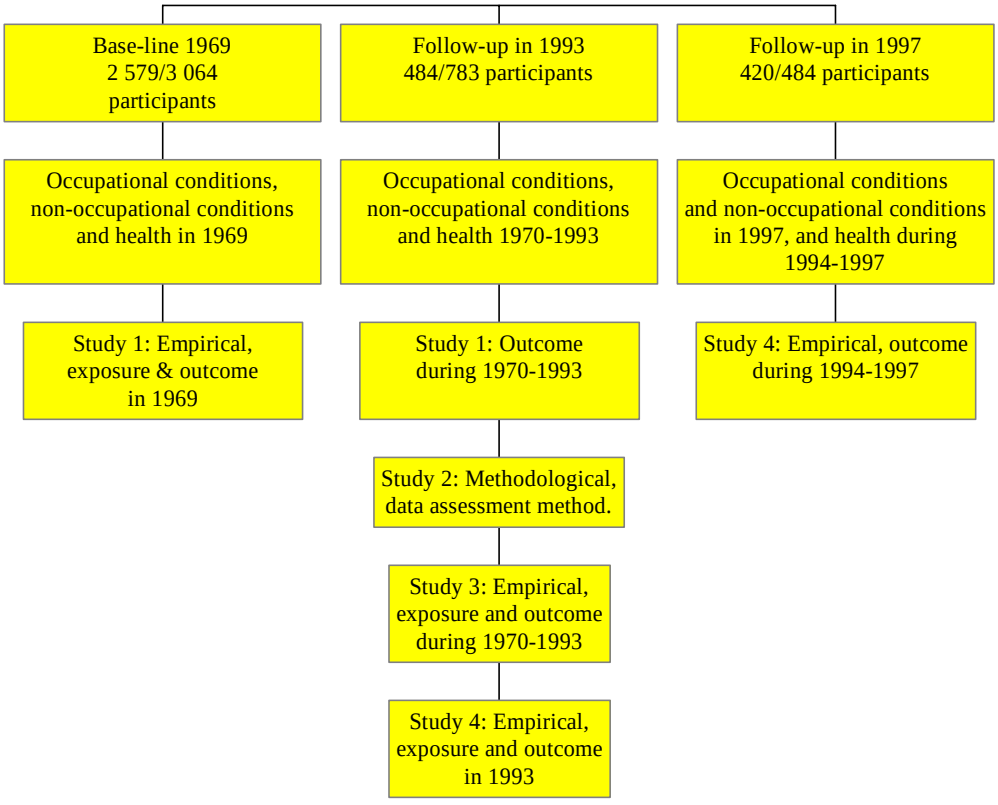

Figure 2. Data collection events in the REBUS study 1969-1997, the number of participants and eligible participant, type of data collected, and the data analyzed in the studies that are included in this thesis.

The study population in the present thesis consists of the participants in the REBUS study. Base-line data in the REBUS study were collected in 1969, and two follow-ups have been made since then.

The years of the base-line data collection and the follow-ups, and the number of participants and eligible participants are given in the figure above (figure 2). The figure also presents the studies included in this thesis and indicates which data they are based on.

In 1969 a survey of approximately 32 000 women and men, age 18 to 65 years, and living in the county of Stockholm, was undertaken (the REBUS study). The purpose was to investigate **a)** the need for medical and social services, **b)** differences between subgroups of the population in their actual needs for services and **c)** the steps taken so far to meet these needs (Bygren 1974). To select the group of participants needed to fulfill the aims of the study in 1969, 32 186 people from 18 to 65 years of age were selected randomly in an age-stratified manner, where the number of eligible participants selected from the youngest age groups was enhanced (Theobald et al 1998). The enhancement was done in order to get a sufficient number of participants with disorders that occur more seldom among younger people.

The numbers of eligible participants from 18 to 25 years of age was 13 011, from 25 to 45 years 13 492, and from 46 to 65 years of age 5 683. These 32 186 persons were sent a questionnaire with questions about their health and possible handicap. On the basis of the answers to these questions, the participants were divided into different groups, according to their assumed health. One group consisted of participants suspected to have very poor health, another group of participants with suspected less poor health, a third group of healthy participants, and a fourth group of participants that had sent back incompletely filled in questionnaires. Out of these 32 186 responders, 3 064 were selected to participate in the study, out of which 2 579 actually did to participate in the REBUS study in 1969. This final selection was based on the four groups, and a group stratified selection was made with enhancement of participants from the group with suspected very poor health, and to a lesser degree, from the group with suspected less poor health (about 30% and 25% respectively of these groups). These enhancements were made in order to get a higher number of participants with disorders that occur more seldom among the population. All 2 579 participants underwent a medical examination and medical diagnoses were given whenever appropriate. For a musculoskeletal diagnosis, symptoms and signs and also consequences for daily living were required.

During 1993, all REBUS participants below the age of 59 years in 1993 who had not been given a musculoskeletal diagnosis in 1969, and who were living in Sweden and available for contact, were identified and asked to participate in a follow-up (N = 783). In 1993 they were from 42 to 58 years of age, with a mean age of 48.1 among women and 48.5 among men (sd 4.3 and 4.5 respectively). Individuals with a low back pain diagnosis, e.g. lumbago, sciatica or lumbago-sciatica in 1969 were excluded from the study population in 1993, while those

participants who reported undiagnosed low back symptoms of minor importance in their daily living in 1969 were included. The reason for this selection is that persons who already had a diagnosis of more serious nature in 1969 can be expected to have chosen occupation accordingly, and thus not to have been exposed to work-related risk factors during most of the studied time periods, therefore they are of less significance as participants in the present study. Musculoskeletal symptoms which influence daily living for a short period, e.g. pain in the lower back for a few days after moving furniture when unaccustomed, occur among a large part of the population and were not presumed to affect the exposure to work-related risk factors to a similar degree as the more serious disorders. In addition to serious musculoskeletal diagnoses, serious psychiatric diagnoses (schizophrenia, mental retardation and chronic alcoholism) were criteria for exclusion from the study population in 1993. The re-examination focused on musculoskeletal disorders and function and previous social, psychological and physical conditions during work and leisure-time. Out of the 783 eligible participants, 484 (62%) participated in the re-examination (252 women and 232 men).

In 1997, those who participated in the follow-up in 1993 were approached and asked to participate in a second follow-up, which was completely based on questionnaire data. Almost 87 percent (88% and 85% among women and men, respectively) from the study-group of 484 participants in 1993 participated in the follow-up in 1997, resulting in 222 women and 198 men, between 46 and 63 years of age at the time of the follow-up. The main aim in 1997 was to examine the predictive value of the information gathered in 1993 concerning physical and psychosocial working conditions for predicting musculoskeletal disorders in 1997.

All analyses of associations were made with SAS statistical software (SAS 1989), and all analyses of differences between groups were made with CIA (Gardner & Altman 1989).

The eligible study group was compared to a sample from the general population in the Stockholm region and a sample from the general population in Sweden as to their income, education and occupation in 1990/1993.

The studies have been reviewed and accepted by the Ethics Committee of Human Research at Karolinska Institute and Huddinge Hospital.

Study 1: Psychosocial and physical risk factors associated with low back pain: A 24-year follow-up among women and men in a broad range of occupations

At the initial examination in 1969, data concerning work and leisure-time conditions were collected by a questionnaire-based interview. Answers on a dichotomous scale concerning 11 occupational factors were grouped into eight types of factors (see appendix 1). Six factors concerning non-occupational conditions, also on dichotomous scales, were grouped into three types of factors. At the examination in 1969, data concerning undiagnosed low back symptoms at the time of the examination were obtained by a questionnaire-based interview.

When the prevalence of low back pain (LBP) in 1969 was calculated, a participant was considered a case of LBP if she or he reported pain, aching or stiffness in the lower back at that interview. At the 1993 re-examination, a retrospective questionnaire about musculoskeletal symptoms during 1970- 92 was filled out. When the cumulative incidence of LBP in 1970-92 was calculated, a participant was considered a case of LBP if she or he had reported medical consultation and treatment (by doctors, physiotherapists or chiropractors) for pain in the lower back during that period, in the questionnaire. At the 1993 re-examination, data concerning musculoskeletal disorders during the last twelve months prior to the re-examination were obtained by a standardized interview. On the basis of this interview, the prevalence of having had LBP defined by pain, aching or stiffness in the lower back in the last twelve months was calculated.

In the analyses of the relationships between potential risk factors in 1969 and LBP, prevalence data from 1969 and 1993 were used, as well as data on the cumulative incidence in 1970-92. The occurrence of LBP was calculated among exposed and non-exposed participants and prevalence ratios (PR) and cumulative incidence ratios (CIR) were calculated. In these calculation of PR and CIR, adjustments for age and some other potential confounding factors were made, by the method proposed by Mantel-Haenszel (Fleiss 1981) – using the module PROC FREQ in the SAS statistical software. The precision of the point estimates of PR and CIR was estimated by test based 95 percent confidence intervals (c.i.) (Miettinen 1976). To adjust simultaneously for age, earlier LBP and the risk factors that in the age adjusted analyses had a lowest confidence interval of 0.8, multivariate analyses were performed (module PROC PHREG in the SAS statistical software) where PR and CIR were used as measures of associations. The precision of the point estimates was also estimated by confidence intervals in these analyses. To adjust for the influence of low back symptoms not given a diagnosis in the analyses of associations 1970-92, LBP in 1969 was treated as a potential confounding factor.

In the multivariate analysis, the effects of additive interaction between work-related and leisure-time related risk indicators were analyzed by using indicator variables, where the PR and CIR for participants exposed to both a work-related a leisure-time risk indicator or only one of these risk indicators were calculated, using the participants not exposed to both indicator factors as reference group (module PROC PHREG in the SAS statistical software). PR and CIR for those participants exposed to both risk indicators are reported, as is the proportion of the excess risk due to interaction $[[OR(A+B) - OR(\bar{A}+B) - OR(A+\bar{B}) + 1] / [OR(A+B)]]$ calculated according to Rothman (1986).

Study 2: Method for retrospective collection of work-related psychosocial risk factors for musculoskeletal disorders: Reliability and aggregation

A structured interview conducted by a psychologist was used to generate data concerning psychosocial conditions at work in 1993 as well as during the time

elapsed since the original examination in 1969. Specifically, information about the current psychosocial situation at work and at four earlier points of time (1992, 1988, 1983 and 1973) was collected. To assist participants in remembering earlier working conditions, an elaborate examination of their work history – occupations and places of work – and of the family situation during the years, was made at the beginning of the interview. This information was used in the interview as a "time ruler" providing anchoring points for retrospective questions. The questions about earlier working conditions were related to these points on the time ruler. For each area under study, the interview started with questions about present conditions, and then the participants were asked to compare the current situation with that prevailing 1, 5, 10 and 20 years previously. The exposure variables were dichotomized (appendix 2).

In addition, 24 randomly selected interviews were tape-recorded and another researcher coded the psychosocial work conditions for these 24 participants from the recordings a second time, thus enabling inter-rater reliability to be calculated. Inter-rater reliability for the 24 participants was calculated on all the present and on all the transformed retrospective psychosocial risk factors, as total agreement (percent) and as weighted kappa with square weights (Bodin 1996).

To reduce the amount of data, and to create more stable variables for epidemiological analyses, indices were constructed on the basis of explorative factor analyses (Principal component analysis), by using the module PROC FACTOR in the SAS statistical software.

To study potential memory bias in the reports of exposure to demanding psychosocial conditions, agreement between self-reported information among our participants and inferred exposure to risk factors was calculated. The inferred exposure was based on an occupation label matrix (Alfredsson, Karasek & Theorell 1982). The agreement between non-exposure from the occupational label matrix and the self-reported non-exposure to some of the risk factors within the REBUS study was calculated and expressed as specificity, or the probability of not reporting exposure to a particular risk factor in a job likely not to involve exposure.

Study 3: Physical and psychosocial factors related to low back pain during a 24-year period: A nested case control analysis

A structured interview, conducted by a psychologist, was used to collect data concerning psychosocial conditions (see the method description for study 2). The psychosocial questions, the answer alternatives and categorization are described in appendix 3. The information about psychosocial working conditions was combined in a factor analysis, resulting in two indices (see the method description for study 2). Information about physical working conditions was collected by questionnaire (Torgén et al 1997). The participants were asked to answer seven questions for each five-year period during 1970-93 if they had remained at the same place of work. The questions, the response alternatives and categorization are

described in appendix 4. The physical working conditions were combined in an index consisting of bent or twisted body postures, hands below knee level, lifting/ carrying loads between 5 and 15 kg and lifting/carrying loads exceeding 15 kg. The information was organized so that the participants were assigned a value for each single year. The factors not included in the indices were used separately in analyses of associations. All separate psychosocial and physical factors and indices was dichotomized **(**appendix 3 and 4).

Information about perceived load outside work, physical exercise in 1993, 1990, 1985, 1980, 1975 and 1970 was collected by a questionnaire (appendix 4). Information about smoking was also collected be a questionnaire, and smokers were defined as participants reporting ten years of smoking or more before the onset of low back pain. The information about conditions during leisure-time was also organized to arrive at a yearly value for each subject.

The outcome in the present study was low back pain (LBP), defined as either medical consultation and treatment (by a doctor, physiotherapist or chiropractor) or sick leave for more than seven consecutive days due to pain in the low back during 1970-1993, as reported in a questionnaire. Another criterion for identifying cases of LBP was reports of low back pain during the last twelve months prior to the examination. For each case, two controls were chosen who were free of back pain. A subject was eligible to be a control until she or he became a case of LBP. If this occurred, the subject could not serve as a control in later years. A subject could be a control on more than one occasion during 1970-1993, but could not be a control for more than one case in the same year. Cases were matched to controls by gender and age (in five-year spans). The matched case control sets were compared as to their physical and psychosocial working conditions during the years immediately preceding the onset year for the cases (the “index” year). For each five-year period analyzed, the annual values for each factor were averaged to give a single value (e.g., a five-year average exposure). All analyses were done for women and men separately.

Age-adjusted conditional odds ratios (OR) for low back pain associated with the separate factors and indices were calculated (in the module PROC FREQ in the SAS statistical software). The precision of the point estimates was estimated by test based 95 percent confidence intervals (c.i.) (Miettinen 1976). Epidemiological interaction between all physical and psychosocial factors at work, and between occupational and leisure-time factors, on the risk of low back pain was analyzed by the method proposed by Rothman, see the method part for study 1 (Rothman 1986). Multivariate analyses of the relationship between different factors and low back pain, with adjustment made simultaneously for age and several factors from work and leisure-time were done by conditional logistic regression (module PROC PHREG in the SAS statistical software).

Study 4: Occupational and non-occupational risk indicators for incident and chronic low back pain in the Swedish general population during a four-year period: The influence from depression?

Information about occupational factors in 1993 was collected by a questionnaire. The cut-off points for the occupational factors is described in appendix 5. Information about the non-occupational factors in 1993 was mainly collected by a questionnaire, but information about the quality of social contacts and coping strategies was collected by an interview (appendix 5).

Low back pain during 1970-1992, later used to define incident low back pain cases and healthy participants, was defined in terms of medical consultation and treatment by a doctor, physiotherapist or chiropractor because of low back pain at any time during the time period. Low back pain in 1993 was defined in terms of medical consultation and treatment by a doctor, physiotherapist or chiropractor because of low back pain (questionnaire) *or* pain in the lower back more than seven consecutive days during the twelve month period preceding the examination in 1993 (data from an interview). Similarly, low back pain in 1997 was defined by medical consultation and treatment by a doctor, physiotherapist or chiropractor because of low back pain at any time during the twelve months preceding the follow-up in 1997, *or* pain in the lower back more than seven consecutive days during the twelve months before answering the questionnaire in 1997. Cases of incident low back pain (ILBP) had had low back pain in 1997 but not in 1993-1996 and in 1970-1992. Cases of chronic low back pain (CLBP) had had low back pain both in 1993 and in 1997, as well as pain in the lower back at some time in 1994-1996. Healthy participants had not had low back pain during 1970-1997.

Depression in 1993 was defined by reports of symptoms of depression at any time during the 12 months preceding the examination (data from an interview by a psychologist). A diagnosis of major depression required at least five symptoms, according to the diagnostic manual. In the present study, sub-clinical depression was studied and those participants who reported at least two depressive symptoms were defined as depressed. In 1997 interviews based on the diagnostic manual were not made, since the follow-up was questionnaire-based. Therefore a standardized questionnaire was used to collect information about depression. Depression was defined as high values on both of two sub scales from the Swedish version of the Nottingham life quality questionnaire, that measure emotional reactions and isolation (Hunt & Wiklund 1987; Wiklund 1992).

Age adjusted odds ratios (OR) for ILBP and CLBP, and for depression, associated with exposure to different occupational and individual factors in 1993 were calculated separately for women and men (using the module PROC FREQ in the SAS statistical software). The precision of the point estimates was estimated by test based 95 percent confidence intervals (c.i.) (Miettinen 1976). In the analyses of association between different occupational and non-occupational factors in 1993 and depression in 1997, the participants with depression in 1993 were excluded. OR for ILBP, CLBP, and depression, adjusted simultaneously for age group (46-55 and 56-36 years), and different occupational and individual

factors, were also calculated, separately for women and men (modified Cox regression, using the module PROC PHREG in the SAS statistical software).

Study 5: Lost-to-follow-up in longitudinal studies of musculoskeletal disorders. Results from the REBUS study

Data from the baseline, the first follow-up, and also information from public records were analyzed (figure 3).

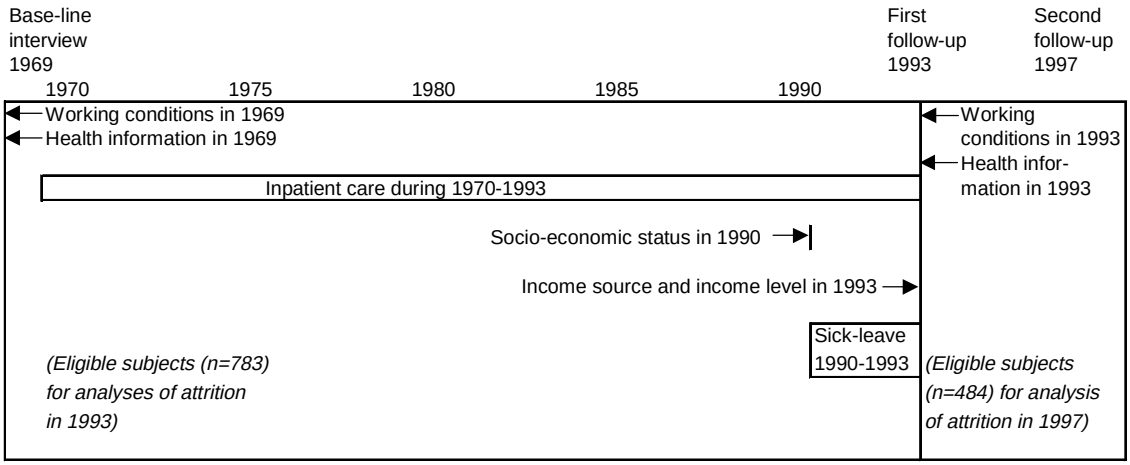

Figure 3. Data collected and analyzed in relation to attrition 1993 and 1997.

In the 1969 study, data concerning psychosocial and physical conditions at work were collected by a questionnaire-based interview (see the method part of study 1), and this information was available for all 783 eligible participants. Also collected was information about the reason for not being gainfully employed in 1969. Information regarding health status gathered in 1969 was the occurrence of low back pain, neck pain, depression and high alcohol consumption. In 1969 all participants were assigned a unmet needs value, based on how many unmet needs of somatic, psychiatric or social service (interview data) they had. All individuals also were assigned an estimated health status, in four classes from suspected very poor health to healthy individuals, based on responses to questionnaire items in 1969.

From Statistics Sweden, information was compiled about occupation, socio-economic status, and level of education and country of birth (Census in 1990). Also income statistics from 1993; main source of income (gainful employment, sick leave, disability pension, and unemployment), income (gross and disposable), and social allowance were compiled. From the National Board for Health and Welfare information about diagnosis and year of care 1970-93 (Inpatient Care Register). The National Insurance Bureau in 1993 provided information on registered sick leave and diagnosis during 1990-93 for those individuals from the

study group who were still living in Stockholm (512 participants). For 161 female and 147 male participants (67%), and for 103 female and 83 male dropouts (62%), applicable information was available. These data were analyzed to examine potential differences between participants and dropouts in registered sick leave because of musculoskeletal disorders.

In relation to attrition in 1997, information about low back pain, neck and shoulder pain, pain in the hands, arms, hips, legs and feet during the twelve months preceding the examination in 1993 were of special interest. Occupational conditions in 1993 that were collected and analyzed in relation to attrition included heavy lifting, physical exhaustion, whole body vibrations, high mental demands, poor emotional climate, low stimulation at work, full time work, shift work and overtime work (described in greater detail in appendix 1). Type of occupation and socioeconomic status, based on occupational codes (Statistics Sweden 1982) were also analyzed.

Differences found between participants and dropouts in these analyses formed the basis for recalculations of formerly made analyses of associations, between occupational conditions and low back pain, where weights where included to compensate for the differences found. In these analyses, weighting was used to compensate for the differences between the study participants and dropouts, as a way to examine the influence of these differences on the previously found associations. It was not differences in the studied variables in themselves that were of interest, but differences in exposure conditions and health status that the observed differences might imply. A marked difference in income or education may indicate differences in both psychosocial and physical conditions at work. By the weighting procedure, the proportion of participants with the characteristic was altered to reflect the proportion of individuals with the characteristic in the entire eligible study group. Hopefully, this resulted in similar proportions of exposure conditions and health status as in the eligible study group as a whole.

Results

The eligible study group was very similar to the inhabitants in the Stockholm region with regard to the factors studied (table 1). This was especially true for the men in the group. In comparison with the whole of Sweden, however, more differences in education and income level were found.

Table 1. Comparison between the eligible study group and the inhabitants in the Stockholm region and in Sweden in 1993; occupation, education and socioeconomic status in 1990, and income statistics from 1993 by participants and dropouts in percent; by gender.

	Women					Men				
	Eligible study group N=420	Stock-holm region # N=1 896	Diff.	Sweden # N=15 506	Diff.	Eligible study group N=363	Stock-holm region # N=1 883	Diff.	Sweden # N=15 934	Diff.
Education										
High school	21.9	24.0	ns	30.4	*	25.9	26.1	ns	35.1	*
College	50.5	42.7	ns	42.2	*	47.4	43.2	ns	40.2	*
University college/university	27.4	31.2	*	26.0		24.8	27.5	ns	22.0	ns
Source of income										
Earned income	71.4	75.4	*	68.8	ns	76.6	77.4	ns	72.9	ns
Earned income + allowance	18.1	13.8	ns	18.6	ns	13.2	11.2	ns	14.9	ns
Social allowance	7.4	6.1	ns	8.7	ns	7.7	7.6	ns	8.8	ns
Neither earned income nor allowance	3.1	4.7	ns	4.0	ns	2.5	3.8	ns	3.4	ns
Gross income (converted)										
Less than $12 740	32.4	30.9	ns	38.6	*	25.1	25.9	ns	28.0	ns
From $12 740 to $25 480	51.7	49.8	ns	50.0	ns	27.8	27.7	ns	36.3	*
From $25 480 to $38220	13.8	16.2	*	9.9	ns	34.4	28.3	*	25.5	ns
$38220 or more	2.1	3.1	ns	1.5	ns	12.7	18.1	*	10.2	*
Country of birth										
Sweden	88.6	78.8	ns	87.2	ns	91.3	89.7	ns	94.1	ns
Scandinavia	6.9	11.6	*	6.7	ns	8.7	10.3	ns	5.9	ns
Occupation										
Teaching	12.2	11.9	ns	10.1	ns	4.0	2.8	ns	6.2	ns
Administration	28.9	30.5	*	21.4	ns	14.2	17.2	ns	15.6	ns
Commercial work	6.0	5.9	ns	6.5	ns	12.1	10.3	ns	12.9	ns
Farming	0.5	0.4	ns	1.3	*	0.6	1.1	ns	0.9	ns
Service work	12.5	12.1	ns	13.9	ns	11.0	12.0	ns	9.4	ns
Health care	20.7	20.7	ns	24.4	*	1.7	3.1	ns	0.9	*
Manufacturing	3.0	3.7	*	5.3	*	21.1	20.9	ns	21.0	ns
Transportation	3.7	4.5	*	2.9	*	6.9	7.4	ns	6.7	ns
Socioeconomic group										
Unskilled worker	18.7	18.6	ns	26.1	*	9.8	12.0	ns	18.2	*
Skilled worker	8,0	6.4	ns	8.07	ns	15.6	14.4	ns	18.3	ns
Lower white collar	24.4	26.3	ns	20.4	ns	10.7	10.0	ns	9.0	ns
Middle and higher white collar	29.7	33.6	*	26.8	ns	41.3	41.2	ns	33.0	*
Creative work	0.2	0.2	ns	0.01	ns	0.6	0.8	ns	0.3	ns
Self employed	3.2	3.4	ns	3.2	ns	6.1	6.7	ns	6.7	ns
No information	15.8	11.6	ns	15.2	ns	15.9	14.9	ns	14.3	ns

= a sample of the population. Diff. = difference in proportion in comparision with the eligible study group.
*=statistically significant difference. Converted = from Swedish crowns in 1998

Study 1: Psychosocial and physical risk factors associated with low back pain: A 24-year follow-up among women and men in a broad range of occupations

The prevalence of LBP in 1969 among women and men was 34 percent and 24 percent, the cumulative incidence of LBP during 1970-92 was 38 percent and 43 percent, and the prevalence in 1993 of having had LBP during the last 12 months was 44 percent and 39 percent, respectively.

Monotonous work was related to LBP in 1969 among women (table 2). In relation to LBP in 1970-92, high physical load and vibrations were risk indicators, as was LBP in 1969 and dissatisfaction with leisure-time among both genders (tables 2 and 3). LBP in 1969 was related to LBP in 1993 among women, and dissatisfaction with leisure-time was related to LBP in 1993 among men.

Table 2. Associations between potential risk factors in 1969 and low back pain in 1969, in 1970-92 and in 1993; women**.**

Potential risk indicators	*LBP in 1969*		*LBP in 1970-92*		*LBP in 1993*	
	PR	(95% c.i.)	CIR	(95% c.i.)	PR	(95% c.i.)
LBP in 1969					1.6	(1.2, 2.2)
Occupational factors						
Blue collar work	0.9	(0.6, 1.4)	0.9	(0.6,1.2)	1.1	(0.8, 1.5)
High physical load	1.4	(0.9, 2.1)	1.1	(0.7,1.7)	1.0	(0.9, 1.5)
High mental load	0.8	(0.4, 1.6)	1.4	(0.8, 2.3)	1.1	(0.7, 1.8)
Poor social support	1.2	(0.7, 2.0)	1.2	(0.8, 2.0)	1.2	(0.8, 1.9)
Vibrations	#		#		#	
Monotous work	1.6	(1.0, 2.6)	1.1	(0.7, 1.9)	0.9	(0.5, 1.5)
Full-time work	0.8	(0.5, 1.1)	1.0	(0.7, 1.4)	1.1	(0.8, 1.4)
Shift work	0.9	(0.4, 1.9)	0.9	(0.4, 1.8)	0.5	(0.2, 1.1)
Overtime work	0.6	(0.2, 1.5)	1.2	(0.6, 2.1)	1.0	(0.7, 2.1)
Non-occupational factors						
Unsatisfactory leisure-time	1.6	(1.1, 2.2)	1.5	(1.1, 2.0)	1.2	(0.9, 1.7)
Few or unsatisfactory social contacts	1.2	(0.8, 1.8)	0.9	(0.6, 1.3)	1.1	(0.8, 1.6)
Additional domestic workload	1.1	(0.7, 1.7)	1.0	(0.6, 1.4)	1.3	(0.9, 1.7)

too few subjects to make analyses possible. PR= prevalence ratio, adjusted for age.

In the multivariate analysis, monotonous work (PR 1.7, c.i. 0.9, 3.2) and few or unsatisfactory social contacts (PR 1.5, c.i. 0.9, 2.7) remained related to LBP in 1969 among women, and none of the included occupational and non-occupational factors remained related to LBP in 1969 among men. In relation to LBP in 1970-1993, LBP in 1969 (CIR 1.7, c.i. 1.1, 2.7 among women and CIR 1.5, c.i. 0.9, 2.5 among men) and unsatisfactory leisure-time (CIR 1.4, c.i. 0.9, 2.3) remained related to LBP among women in the multivariate analyses. In relation to LBP in 1993, LBP in 1969 remained related to LBP in 1993 among women (PR 1.6, 1.0, 2.4) and unsatisfactory leisure-time to LBP in 1993 among men (PR 1.8, c.i. 1.0. 3.4) in the multivariate analyses.

Table 3. Associations between potential risk factors in 1969 and low back pain in 1969, in 1970-92 and in 1993; men.

Potential risk indicators	*LBP in 1969*		*LBP in 1970-92*		*LBP in 1993*	
	PR	(95% c.i.)	CIR	(95% c.i.)	PR	(95% c.i.)
LBP in 1969					1.7	(1.2, 2.3)
Occupational factors						
Blue collar work	1.2	(0.8, 2.0)	1.0	(0.7, 1.4)	1.0	(0.7, 1.4)
High physical load	1.4	(0.8, 2.4)	1.4	(1.0, 2.0)	1.1	(0.8, 1.6)
High mental load	1.2	(0.6, 2.4)	1.0	(0.6, 1.5)	1.1	(0.6, 1.8)
Poor social support	0.6	(0.2, 1.6)	0.7	(0.4, 1.2)	1.1	(0.6, 1.8)
Vibrations	0.9	(0.5, 1.8)	1.4	(1.0, 1.1)	1.3	(0.8, 2.0)
Monotous work	0.8	(0.3, 1.9)	1.0	(0.6, 1.7)	1.5	(0.9, 2.4)
Full-time work	0.4	(0.1, 1.0)	2.1	(0.5, 8.4)	#	
Shift work	1.2	(0.5, 2.7)	0.5	(0.2, 1.0)	0.6	(0.3, 1.3)
Overtime work	0.9	(0.5, 1.5)	1.1	(0.8, 1.5)	0.6	(0.4, 0.9)
Non-occupational factors						
Unsatisfactory leisure-time	1.1	(0.7, 1.9)	1.5	(1.1, 2.0)	1.5	(1.0, 2.1)
Few or unsatisfactory social contacts	1.2	(0.7,2.0)	1.4	(1.0, 1.9)	1.5	(1.0, 2.1)
Additional domestic workload	1.8	(0.8, 4.1)	1.7	(1.0, 2.9)	1.5	(0.9, 2.7)

too few subjects to make analyses possible. PR= prevalence ratio, adjusted for age

Interactions between few or unsatisfactory social contacts outside work, as well as dissatisfaction with leisure-time, and a number of work-related psychosocial and physical factors were found to increase the risk of LBP among both genders during the studied time periods. Among women, the proportion of the excess risk due to interaction ranged between 0.2 and 0.8 (most commonly between 0.5 and 0.8). The corresponding proportions among men were 0.1 and 0.5. The conclusions drawn in this study were that conditions in leisure-time exert a long-term influence on low back pain. In this study work-related factors had a long-term effect mainly in interaction with leisure-time factors.

Study 2: Method for retrospective collection of work-related psychosocial risk factors for musculoskeletal disorders: Reliability and aggregation

Seventeen out of the 19 psychosocial factors examined were considered reliable in the inter-rater analyses, i.e. had a kappa value above 0.4 in 1993 and a kappa value above 0.4 for two or more of the earlier years. With the exception of monotonous work and satisfaction with work, all variables were therefore considered suitable for inclusion in further analyses.

The aggregation of data resulted in two psychosocial factors, or indices, that were stable at all four points in time among both genders. One index consisted of poor social support from colleagues and closest superiors, no dependence on help from colleagues in managing work tasks, and little social interaction with

colleagues outside work. This index was regarded as a reflection of the social relation dimension at work. The second index consisted of few demands for new knowledge, low decision latitude and little possibility of influencing work pace. The dimension reflected by this index was regarded as the demands and control in the participants' work situation, i.e. reflecting low influence over work conditions.

The overall pattern in the material was that the stability in the reports of psychosocial conditions was high or rather high for most of the potential risk factors, with some degree of decrease further back in time. The degree of decrease differed between the outcomes and among the genders. The decrease in stability of the retrospective risk factors was higher among women then among men, and risk factors consisting of social interactions showed less decrease than those characterized by various work-task demands.

The agreement between self-reported non-exposure and inferred exposure was moderate to high for most of the studied risk factors at several or all of the studied years (i.e. a specificity between 0.6 and 1.0).

Study 3: Physical and psychosocial factors related to low back pain during a 24-year period: A nested case control analysis

Among the 484 participants, 114 women and 108 men fulfilled the criteria for low back pain during the studied period. More cases occurred during the later part of the period, especially among the youngest age group.

In the age-adjusted analyses with five-year exposure periods, some physical and psychosocial factors tended to be associated with low back pain in both genders **(**table 4).

Table 4. Age-adjusted odds ratios and confidence intervals for the associations between low back pain and the factors the last five years preceding the index year considered; by gender.

Potential risk indicators	*Women*			*Men*		
	OR	95% c.i.	Obs*	OR	95% c.i.	Obs*
Occupational factors						
Heavy physical workload	1.6	0.9, 2.8	25	1.4	0.9, 2.2	40
Sedentary work	1.5	0.8, 2.6	32	1.5	0.9, 2.7	32
Whole body vibration	1.5	1.0, 2.5	36	0.8	0.5, 1.3	41
High perceived work load	1.0	0.6, 1.7	33	1.0	0.6, 1.6	50
Low influence over work conditions	1.5	0.9, 2.5	37	0.7	0.4, 1.1	26
Poor social relations	1.3	0.7, 2.3	29	2.0	1.2, 3.2	42
Overtime work	0.7	0.4, 1.4	37	1.9	1.0, 3.2	43
Shift work	1.9	0.9, 3.9	19	0.8	0.4, 1.9	10
Few possibilities of development	1.1	0.6, 2.3	22	1.1	0.4, 1.8	24
Time pressure	1.1	0.5, 2.5	14	1.1	0.6, 2.4	9
Social disturbances	0.7	0.4, 1.2	55	1.4	0.5, 3.6	47
Technical disturbances	0.8	0.5, 1.5	73	1.0	0.6, 1.8	57
Risk of accidents	0.8	0.5, 1.3	63	0.8	0.5, 1.4	57
Non-occupational factors						
High perceived load outside work	1.0	0.6, 1.5	44	1.6	1.0, 2.7	38
No physical exercise during leisure time	1.2	0.8, 1.9	17	1.1	0.7, 1,8	14
Smoking more than 10 years	1.3	0.9, 2.1	62	1.1	0.7, 1.8	64

Obs* = observed number of exposed cases.

A number of interaction variables consisting of two occupational factors were identified, as were a number of interactions between one occupational and one leisure-time factor (table 5). Three of the interaction variables for women and two for men included high perceived workload, which was not associated with low back pain in itself. Among men, poor social relations interacted with both occupational and leisure-time factors, as did low influence over work conditions among women. The combinations of heavy physical workload, vibration, perceived workload with overtime work, shift work and poor social relations mainly occurred among participants occupied in manufacturing, transport and farming. Sedentary work and overtime were present in administrative and commercial jobs. Low influence over work conditions together with high perceived workload and vibrations was reported among women in all sectors, with the exception of teaching.

Table 5. Age-adjusted odds ratios, confidence intervals, proportion of the excess risk for the associations with corresponding confidence intervals between low back pain and the two-way interaction variables the last five years preceding the index year considered; by gender.

Work related factors combined					
	OR	95% c.i.	prop.	95% c.i.	Obs*
Women					
Heavy physical workload and time pressure	3.3	0.8, 13.9	0.7	0.2, 1.2	5
High perceived load and low influence over work conditions	1.6	0.8, 3.1	0.4	-0.2, 1.0	17
High perceived load and shift work	1.7	0.8, 4.0	0.6	0.0, 1.2	12
Whole body vibration and low influence over work conditions	2.2	1.0, 4.6	0.4	-0.2, 1.2	16
Shift work and overtime work	3.5	1.0, 11.6	0.9	0.8, 1.2	12
Men					
Heavy physical workload and few development opportunities	2.4	0.9, 6.4	0.6	0.4, 1.1	9
Sedentary work and poor social relations	3.1	1.1, 8.7	0.7	0.4, 1.1	11
High perceived load and poor social relations	2.2	1.1, 4.6	0.6	0.1, 1.0	10
High perceived load and overtime work	2.2	0.9, 5.5	0.5	0.0, 1.0	14
Poor social relations and overtime work	3.1	1.4, 7.1	0.4	-0.1, 1.0	12
Technical disturbances and high physical workload	1.8	0.8, 4.2	0.5	-0.1, 1.0	13
Factors at work and during leisure-time combined					
Women					
Sedentary work and smoking more than ten years	2.1	0.9, 4.6	0.5	0.1, 1.0	20
High perceived load and lack of physical exercise	1.9	0.9, 4.0	0.7	0.2, 1.1	4
Poor psychosocial work characteristics and lack of physical exercise	2.2	1.0, 4.6	0.6	0.1, 1.0	4
Shift work and lack of physical exercise	2.4	1.0, 5.4	0.8	0.4, 1.1	4
Men					
Poor social relations and high perceived load outside work	4.8	2.0, 11.5	0.7	0.3, 1.0	10
Poor social relations and smoking more than ten years	1.6	0.8, 3.2	0.4	0.2, 1.1	16

* = observed number of cases exposed to different combined factors

The multivariate analysis results were similar to those from the crude analyses, except that shift work no longer appeared to be associated with low back pain among women, probably because of the correlation with low influence over work conditions (table 6). The final models for each gender were tested with factors and

interaction terms for a one-year period before the onset of low back pain instead of five years (table 6). No dramatic differences were found between the analyses of one- and five-year periods.

Table 6. Adjusted multivariate estimates* of associations between factors five years and one year before the onset and low back pain; by gender.

Women	OR	95% c.i.	*Men*	OR	95% c.i.
5 years before onset			*5 years before onset*		
Heavy physical workload	1.9	1.1, 3.6	Heavy physical workload	1.5	0.9, 2.3
Sedentary work	1.6	0.9, 2.8	Sedentary work	1.7	0.9, 3.1
Vibration and low influence over work conditions	1.9	0.9, 4.3	Poor social relations and overtime work	3.7	1.5, 9.1
Vibration	1.0	0.6, 2.4	Poor social relations	1.6	0.8, 3.0
Low influence over work conditions	1.2	0.6, 2.3	Overtime work	1.6	0.8, 3.3
More than 10 years of smoking	1.3	0.8, 2.0	High perceived load outside work	1.9	1.1, 3.3
1 year before onset			*1 year before onset*		
Heavy physical workload	2.2	1.2, 4.0	Heavy physical workload	1.6	0.9, 2.8
Sedentary work	1.7	1.0, 3.1	Sedentary work	1.6	0.8, 2.9
Vibration and low influence over work conditions	1.5	0.7, 3.0	Poor social relations and overtime work	3.1	1.3, 7.2
Vibration	0.8	0.4, 1.6	Poor social relations	1.2	0.5, 2.6
Low influence over work conditions	1.3	0.7, 2.8	Overtime work	1.1	0.6, 2.3
More than 10 years of smoking	1.2	0.8, 2.2	High perceived load outside work	1.7	1.0, 2.9

* = age also included in the model.

Study 4: Occupational and non-occupational risk indicators for incident and chronic low back pain in the Swedish general population during a four-year period: The influence from depression?

The proportion with ILBP in 1997 was 14 percent among women and 15 percent among men and the proportion with CLBP 13 percent among women and 10 percent among men. Nine percent of the women and ten percent of the men were depressed in 1997. Twenty percent of the women with ILBP and 4 percent of the women with CLBP were depressed. The corresponding proportions among men were 10 percent and 11 percent.

In the age-adjusted analyses, no physical factors were associated with ILBP among women but some were associated with CLBP (table 7). Psychosocial factors were associated both with ILBP and CLBP. None of the examined non-occupational factors were associated with ILBP, but poor quality of social contacts was associated with CLBP. Depression in 1993 was not related to either ILBP or CLBP among women. Several psychosocial and physical occupational factors and non-occupational factors were related to depression among women.

Several physical factors, but none of the psychosocial factors, were reliably associated with ILBP and CLBP among men, as were some non-occupational factors (table 8). Few occupational and some non-occupational factors were related to depression among men.

Table 7. Associations between the different occupational and individual factors in 1993 and chronic and incident LBP and depression in 1997 found in age adjusted analysis; women.

	Incident LBP N=93		Chronic LBP N=92		Depression* N=202	
	OR	c.i.	OR	c.i.	OR	c.i.
Occupational factors						
Physical conditions						
Sedentary work	1.2	0.7, 2.1	0.6	0.3, 1.2	0.6	0.7, 2.0
Whole body vibrations	1.2	0.7, 2.1	1.0	0.6, 1.8	0.7	0.2, 2.4
Work with hands below knee-level	1.2	0.6, 2.7	1.4	0.7, 2.6	3.6	1.4, 9.4
Bent and twisted body postures	1.2	0.7, 2.1	1.3	0.8, 2.2	3.0	1.1, 8.6
Lifting 5-15 kg	1.2	0.7, 2.1	1.0	0.6, 1.8	2.3	0.8, 6.3
High perceived workload	1.4	0.8, 2.4	1.9	1.1, 3.1	1.6	0.7, 3.4
General conditions						
Full time work	0.7	0.4, 1.2	0.6	0.4, 1.0	0.5	0.2, 1.1
Overtime work	1.3	0.7, 2.2	1.4	0.7, 2.6	1.1	0.4, 2.6
Shift work	1.9	1.1, 3.3	2.1	1.2, 3.6	3.3	1.6, 7.3
Temporary employment	2.5	1.3, 4.7	1.9	0.6, 5.6	2.5	0.9, 6.6
Psychosocial conditions						
Low occupational pride	2.2	1.3, 3.7	1.6	0.9, 2.9	1.3	0.5, 3.5
Job strain	2.3	1.3, 4.0	1.7	0.9, 3.2	3.5	1.6, 7.4
Few possibilities to learn new things	2.6	1.6, 4.2	1.9	1.1, 3.2	1.5	0.6, 3.4
No education at employer's expense	1.7	1.0, 2.8	1.8	1.1, 3.1	2.6	1.1, 6.4
Non-occupational factors						
Individual factors						
Low frequency of social contacts	0.9	0.5, 1.6	0.8	0.4, 1.4	1.4	0.6, 3.0
Poor quality of social contacts	1.1	0.6, 2.1	2.0	1.1, 3.4	3.1	1.5, 6.6
Smoking	1.3	0.7, 2.3	1.2	0.7, 2.2	0.9	0.4, 2.2
High perceived physical load	1.4	0.9, 2.4	1.4	0.8, 2.4	2.6	1.2, 5.5
Inadequate coping strategies	1.5	0.7, 2.9	1.7	0.9, 3.2	3.6	1.6, 7.1
Earlier health problems						
Depression 1993	0.5	0.2, 1.4	0.8	0.4, 1.9	#	
LBP 1993	#		#		1.3	0.3, 5.1

* excluding subjects with depression 1993.
# was not calculated.

When several occupational and non-occupational factors from 1993, and age, were considered in the same analyses, a small number of factors remained related to the studied outcomes among women (table 9). Also among men, a small number of factors remained in the multivariate model for the studied outcomes.

Table 8. Associations between the different occupational and individual factors in 1993 and chronic and incident LBP and depression in 1997 found in age adjusted analysis; men.

	Incident LBP N=90		Chronic LBP N=79		Depression N=178	
	OR	c.i.	OR	c.i.	OR	c.i.
Occupational factors						
Physical conditions						
Sedentary work	0.3	0.1, 0.5	0.6	0.3, 1.2	1.0	0.4, 2.4
Whole body vibrations	2.0	1.1, 3.5	1.0	0.5, 2.2	0.9	0.4, 2.0
Work with hands below knee-level	1.9	0.9, 3.9	4.5	2.2, 9.0	0.3	0.1, 1.5
Bent and twisted body postures	1.1	0.6, 2.0	1.3	0.6, 2.9	0.9	0.4, 2.1
Lifting 5-15 kg	4.0	2.4, 6.7	3.7	1.9, 7.4	1.1	0.5, 2.4
High perceived workload	1.7	1.0, 2.8	1.6	0.8, 3.2	1.1	0.5, 2.4
General conditions						
Full time work	0.4	0.2, 0.8	0.3	0.1, 0.5	0.6	0.2, 1.6
Overtime work	0.9	0.5, 1.5	0.9	0.4, 1.7	0.6	0.2, 1.3
Shift work	1.5	0.7, 2.9	0.9	0.3, 2.9	2.2	1.0, 5.2
Temporary employment	1.6	0.4, 6.3	1.0	0.1, 7.7	2.0	0.4, 9.4
Psychosocial conditions						
Low occupational pride	1.5	0.7, 3.0	1.5	0.6, 3.8	2.4	1.1, 5.5
Job strain	2.2	0.8, 5.8	2.1	0.5, 8.8	2.1	0.7, 6.8
Few possibilities to learn new things	1.4	0.7, 3.0	1.2	0.4, 3.5	0.4	0.1, 2.1
No education at employer's expense	0.8	0.5, 1.3	1.2	0.6, 2.4	0.6	0.3, 1.3
Non-occupational factors						
Individual factors						
Low frequency of social contacts	1.7	1.0, 2.8	1.3	0.7, 2.7	1.6	0.7, 3.5
Poor quality of social contacts	1.0	0.5, 1.8	2.4	1.2, 5,3	2.0	0.9, 4.7
Smoking	0.5	0.3, 1.1	1.1	0.5, 2.3	2.4	1.1, 5.2
High perceived physical load	1.4	0.8, 2.4	1.7	0.8, 3.5	0.8	0.2, 2.1
Inadequate coping strategies	1.3	0.6, 2.8	3.8	1.9, 7.6	3.3	1.5, 7.6
Health problems						
Depression 1993	0.9	0.3, 2.4	2.5	1.2, 5.3	#	
LBP 1993	#		#		0.8	0.8, 3.9

* excluding subjects with depression 1993.
# was not calculated.

Some studies have reported that a low level of education and low socioeconomic status is related both to lower back pain and to depression (Averill et al 1996; Dionne et al 1998; Lantza et al 1998; Ling & Dohrenwend 1993). To further elucidate these findings in the present study, separate analyses were made for women and men with lower (upper level of compulsory school or vocational school) and higher (upper secondary school, college, or university education) educational level. Among women with lower education, physical factors were associated with ILBP and with CLBP. In the additional analyses smoking and high perceived physical load were associated with ILBP among women with higher education. Physical factors associated with depression among women were more strongly related to depression among those with lower education, than

among those with higher education. The main impression from these additional analyses was that there were differences as to which factors were related to the different outcomes among women with different educational levels. Among men, however, educational levels were not associated with clear differences in pattern of associations for ILBP, for CLBP, or for depression. Nevertheless, poor quality of social contacts and inadequate coping strategies were more strongly related to depression among men with lower education, than among men with higher education, and the opposite was true for job strain and higher perceived physical load outside work. Still, the main impression from the additional analyses was that level of education was not as strongly a modulating factor among men as among women.

Table 9. Adjusted multivariate estimates* of associations between occupational and individual factors in 1993 and chronic and incident LBP and depression in 1997.

	Women			Men	
	OR	c.i.		OR	c.i.
Incident low back pain			*Incident low back pain*		
Temporary employment	2.8	1.2, 3.7	Lifting 5-15 kg	4.1	2.1, 8.1
Job strain	2.3	1.1, 4.7	Poor quality of social contacts	2.0	1.1, 4.0
Chronic low back pain			*Chronic low back pain*		
High perceived work load	1.9	1.1, 3.6	Work with hands below	4.7	1.9, 12.1
Shift work	2.3	1.1, 4.7	knee-level		
Few possibilities to learn new things	2.3	1.1, 4.8	Inadequate coping strategies	3.9	1.5, 10.1
Depression			*Depression*		
Job strain	2.0	1.0, 4.1	Shift work	2.1	1.1, 4.2
Inadequate coping strategies	3.0	1.6, 5.7	Smoking	1.9	1.0, 3.8
			Inadequate coping strategies	3.4	1.8, 6.7

*age is included in the analyses.

Study 5: Lost-to-follow-up in longitudinal studies of musculoskeletal disorders. Results from the REBUS study

Some differences between dropouts and participants were found. Almost twice as many female dropouts as participants in 1993 had monotonous work in 1969, and none of the participants, but two percent of the dropouts, had overtime work in 1969. Among male dropouts and participants, no such differences were found. More than twice as many male dropouts than participants had high alcohol consumption in 1969, and more than a third of the dropouts and less than a fourth of the participants had low back pain in 1969. Fewer women among the dropouts than among the participants had a suspected very poor health in 1969 (19% and 31%, respectively). Among women, somewhat more dropouts than participants had unmet needs for psychiatric care. Women with unmet needs of both somatic and psychiatric care and social needs were thrice as common among the dropouts

(9% vs. 3%, among participants). Among both women and men, the dropouts had a lower educational level than the participants, but more markedly so among women, where 29 percent of the dropouts and 18 percent of the participants had only high school education. More women among the dropouts than among the participants had disability pension (18% and 5%, respectively) and more than a third of the dropouts and slightly more than a quarter of the participants had a low gross income (less than $12 741 per year). When hospitalization during these 24 years was analyzed, no statistically significant differences between dropouts and participants in the different diagnostic groups were found, although the occurrence of hospitalization because of psychiatric disorders and alcohol and drug abuse diagnosis were higher among dropouts than among participants. Among women no statistically significant difference in registered sick leave because of musculoskeletal disorders was found, although sick leave because of musculoskeletal disorders was less prevalent among dropouts than among participants. Fewer male dropouts than participants had registered sick leave because of hand-arm disorders. No difference between the two groups was found regarding sick leave periods longer than 30 days, either because of musculoskeletal disorders or other disorders.

When the information from 1993 was analyzed in relation to attrition in 1997, only a few differences between dropouts and participants were found. Half of the female dropouts and a third of the participants had heavy lifting. Among men, less than a third of the dropouts and almost half of the participants belonged to the middle and high white collar group, and only three percent of the dropouts and more than a tenth of the partici-pants were depressed.

In the three sets of weighted analyses, very few changes in the ratio estimates could be found in the different steps of the procedure. When changes occurred, the risk estimates increased or decreased only 0.1 or 0.2, although the ratio estimate for overtime work during 1970-1993 decreased markedly in all the weightings (from 1.9 to 1.4 or 1.5).

Discussion

Risk indicators for low back pain

The importance of psychosocial conditions and of interaction effects
As stated in the introduction, in previous studies of musculoskeletal disorders the focus has mostly been on the physical conditions at work, or, in some studies, both physical and psychosocial conditions at work. Very seldom has information about non-occupational conditions been included in the analyses of associations between various conditions and musculoskeletal disorders.

The importance of psychosocial conditions at work in relation to low back pain was shown in several of the studies presented here. Both separately and in interaction with physical conditions and with conditions from family and leisure-time, psychosocial conditions at work were clearly related to low back pain among both women and men.

Many more psychosocial factors at work were related to low back pain among women than among men in the present thesis. Monotonous work was a risk indicator for both genders, but otherwise, the psychosocial risk indicators were not the same among women as among men. Conditions such as low influence over work conditions, shift work, low occupational pride and few possibilities to learn new things were risk indicators for LBP among women, and overtime work and poor social relations were risk indicators for LBP among men. These differences cannot solely be explained by differences in reported exposure (i.e. only women being exposed to low influence over work, or only men being exposed to poor social interaction at work), since for many of these psychosocial conditions the proportion of exposed participants was the same in both genders, but they may be explained by differences in exposure intensity. Thus, very few psychosocial risk indicators for LBP were found at work among men, but in interaction with physical conditions at work and non-occupational conditions they were strongly related to LBP.

Psychosocial conditions at work and psychosocial conditions outside work can be hypothesized to interact strongly with each other. In the present thesis this was shown in study 1, and to a greater degree among women than among men. Among women, shift work and high mental and physical load were the work-related factors that contributed to the highest proportion of the excess risk for LBP in interaction with psychosocial factors outside work. This seems to reflect women's total workload, rather than being a result of personality traits or role conflicts due to conflicting demands from work and family life. This assumption is supported by the low interaction effect between few or unsatisfactory social contacts in leisure-time and poor social support at work. Among men, the pattern of interaction between work and factors outside work was more diverse. The strong interaction between few or unsatisfactory social contacts in leisure-time and poor social support at work may thus indicate the effect of personality traits. Above all,

the proportion of the excess risk due to interaction among men is low, indicating that men's life at work and outside work does not interact to influence health endpoints such as LBP.

In study 3, no information about psychosocial conditions outside work was available, and the analyses of interactive effects from occupational and non-occupational conditions on LBP considered only physical and life stile factors. Different interaction terms were found to be important for women and for men. For some of the interactions found to increase the risk of LBP among women, fewer men than women reported the combination of factors, but for others the proportions were equal among the genders or even higher among men. The interaction of whole body vibration and low influence over work conditions was associated with low back pain among women. The concurrent presence of whole body vibration and low influence over work conditions was mainly found among women occupied in administration, health care and service work, which may involve driving. Most whole body vibration emanates from driving and the vibration increases when the speed of the vehicle increases (Hansson & Zylber-stein 1982). If the drivers cannot influence the work pace and the planning of the work, they also have little possibility to reduce vibration by reducing vehicle speed. The combination of whole body vibrations and low influence over working conditions occurred twice as often among men as among women; still it was only a risk indicator among women.

The concurrent presence of overtime work and poor social relations was mainly found in administration, commercial work, farming, science and manufacturing, and was strongly associated with low back pain among men. This situation may reflect a work situation in which the subjects work overtime at work places where the possibility of getting help with work tasks, when needed, is small. This may result in a very highly demanding work situation that lasts many hours at a time and overexertion may occur. The proportions of subjects with concurrent presence of overtime work and poor social relations at work was very similar among the genders (9.7% and 10.8% among women and men, respectively) and still it was only a risk factor for low back pain among men. In study 3, the proportion of the excess risk due to interaction between psychosocial and physical conditions at work was very similar among women and men.

In the present thesis, it is not possible to test the different hypotheses concerning which mechanisms may be involved in the development of low back pain, but occupational and non-occupational conditions did intensify each other's effect on low back pain, as did psychosocial and physical conditions at work. Several of the proposed hypotheses seem, from our results, to be plausible.

The quarter century perspective

The work force has changed during the time period covered in the study, mainly through a decreased proportion of subjects employed within the manufacturing industry as mentioned in the introduction, and this trend can be seen also among the REBUS participants. Seventy-eight percent of the women and 77 percent of

the men reported that they had changed work at least once between 1970 and 1993. When examining occupational codes, 72 percent of both genders had changed their occupation. Most of the subjects who had changed occupation had changed from manual work to administration. Since the REBUS study group is a panel, the educational level has not changed as it has in the Swedish society in general.

The pattern of gainfully employment differed to certain degree among women and men. Out of the 484 participants in the follow-up in 1993, 46 percent of the women and 80 percent of the men had been gainfully employed continuously since 1973. Among the others, the majority was not employed in one or two years only. Among the women with one or two years without gainful employment, the majority was without employment early in the period, probably because of childbirth and taking care of small children. Unemployment among men was about equally distributed throughout the follow-up period.

LBP is common in the general population, and so also among the REBUS participants. About half of the participants had had LBP in various degrees and various occurrences during the quarter of a century, which is very reasonable, when comparing to the life time incidence rates of 51-50 percent mentioned in the introduction.

The long-term effects on low back pain of adverse conditions on and off work were studied in several of the included studies in this thesis. Several findings in these studies indicate that LBP can occur after years of adverse conditions. Thus, the induction period from the onset of certain conditions to onset of LBP was up to 24 years for unsatisfied leisure-time, alone or in combination with some work-related factors. This may reflect a personality trait leading to certain behaviors, rather than being effects of external conditions.

Incident LBP could occur up to five years (study 3) and four years (study 4) of exposure to risk indicators on and off work. The ratio estimates were in general not higher after five than after one year of exposure, which might be expected of postulating an accumulating effect of long-term exposure. On the other hand, an accumulation effect may have been hidden because the most vulnerable individuals leave high-risk jobs sooner than the more robust individuals (healthy worker effect). Both psychosocial and physical factors could exert their effects up to five years. The results suggest that a long-term perspective increase the information that can be gained from epidemiological studies of LBP.

Gender differences

The main differences between the genders found in the present thesis were differences in exposure levels and, to a certain extent, differences in risk indicators. The differences in exposure levels can most probably be explained by the gender segregated labor market. The differences in risk indicators may be explained in several ways.

Psychological differences between the genders may be of relevance for both choices of occupation and for how different individuals react to demands in

working life, and thereby exert an influence over the exposure conditions and the effects of various exposures, as sketched in figure 1. In everyday life, statements like “women are especially good at …” or “men are like that” can be heard as explanations for why women and men work within different occupations. The way women and men express themselves verbally can, hypothetically, affect their possibility of influencing their working conditions. Potential differences in language and communication between the genders include that women’s language seeks to preserve intimacy and avoid isolation, whereas men’s language is focused on preserving independence and avoiding failure (Lindelöw & Bildt Thorbjörnsson 1998). However, the main impression from various studies of psychological gender differences was that the differences between the genders were small and the differences between individuals were large. Cultural norms about what jobs and what work tasks are suitable for women or for men are probably a more important explanatory factor for the segregation of the genders in different occupations and between the genders at the same work place than psychological differences. This has been shown when it comes to norms for which gender is most suitable to perform certain work tasks within the same work place (West-berg-Wohlgemuth 1996).

Differences in language and communication between the genders could, hypothetically, influence the reports of occupational conditions. The stability over time of the reported earlier psychosocial working conditions in study 2 differed between genders and among the psychosocial risk indicators. Differences between the genders in language and communication were not thought to be the reason for this difference in stability. In general, as was shown in study 2, women seem to have experienced larger changes at work than men had during the period studied. This was not because women had changed their place of work more often than men. One possible explanation could be that more women than men went through years when they were not gainfully employed (because of giving birth and taking care of small children) and that they were given other work tasks than before the parental leave when returning to work. Another plausible explanation is that the occupational sector in which most women work, the public sector, has gone through major reorganizations and downsizing during the later part of the study period. Factors related to social interaction appeared to be more stable than factors pertaining to work tasks, maybe because of the influence of personality traits. In study 3, the concurrent presence of overtime work and poor social relations was reliably related to LBP among men, but not among women. This may reflect a work situation in which the subjects work overtime at work places where the possibility of getting assistance, when needed, is small (as noted above) but also a poorer ability among men than among women to interact with their colleagues.

Gender differences in coping strategies – a potential intermediary link between occupational conditions and musculoskeletal disorders – have been inferred by some researchers (Lindelöw & Bildt Thorbjörnsson 1998). In many studies, women and men had very different working conditions, which might have been the explanation for the observed differences in choice of coping strategy. This

assumption was supported by the results of a study in which the study participants of both genders had similar work tasks (Korabik, McDonald & Rosin 1993). The choice of coping strategies was very similar among women and men, indicating that it was the coping strategies available at work for women and men that differed, rather than the preferences among them. This is in agreement with the higher ratio estimate for inadequate coping strategies in relation to CLBP among men in study 4. On the other hand, the concurrent presence of high perceived workload and time pressure was related to LBP among women but not among men, which may indicate that poorer actual coping strategies were available for women than for men in some work settings.

Physical differences – such as physical capacity and muscle strength – between women and men may be one reason for the higher prevalence of musculoskeletal disorders in general among women. The average woman and the average man differ in height and length, although the within-gender variation is large (Pheasant 1986; Messing & Kilbom 1998). The average woman is about the same height as the shortest five percent of men, her sitting height about the same sitting height as the lowest five percent of men, and the differences in arm length and hand breadth are the same. Such differences may influence the consequences of mechanical load among women, since hand-held tools, work stations, height of work tables and shelves often are designed to suit the average man. Also for shorter men this will be a potential source of harmful influence. The gender difference in weight is smaller, and about 25 percent of a woman's and about 15 percent of a man's body weight consists of fat. Differences in physical capacity have been found between the genders (Åstrand & Rodahl 1969; Messing & Kilbom 1998). Women have a lower aerobic power, 30 percent when no correction for body weight was made and 10-15 percent when differences in body weight were accounted for. Women on the average do not have the same muscle strength as men, and the gender difference in muscle strength is most pronounced in the upper part of the body (Messing & Kilbom 1998). The lower muscle strength among women is to some extent compensated by greater endurance (Clarke 1986; Jörgenson 1987). In the present thesis, physical risk indicators for LBP appeared more strongly among men, but it was the same indicators as for LBP among women. Since women are less strong than men, and also shorter, and the work places are often designed to suit a man's body it would have been plausible to expect the physical risk indicators to appear more strongly among women than among men. In study 4, there was some evidence that women were exposed to physical exposures at lower intensity and lower duration levels than men were, which may explain the lower ratio estimates for the physical risk indicators for LBP among women. When this was examined in the present study, a difference in intensity was found regarding vibrations – where only 4 percent of the exposed women and as many as 18 percent of the exposed men were exposed more than half of the day – and bent and twisted body postures – where 83 percent of the exposed women and 69 percent of the exposed men were exposed every working day. For the other occupational and non-occupational factors, no significant difference in intensity

could be found. In study 3, the combination of whole body vibration and low influence over working condition occurred twice as common among men as among women, but were reliably related to LBP among women only. Women's shorter length and muscle strength may be the reason for that. The concurrent presence of high perceived workload and low influence over working conditions was related to LBP among women but not to LBP among men, a difference which also may be caused by the physical differences between women and men.

Incident and chronic low back pain

In the age-adjusted analyses of occupational factors in study 4, there were some differences between ILBP and CLBP regarding the risk indicator pattern. However, the main impression was that it was the level of the observed odds ratios rather than the pattern of associations that differed. These results may indicate that the influence of occupational conditions is similar in the development and maintenance of low back pain, and thus that interventions aimed at primary prevention also could be expected to have a preventive effect on chronic LBP among the employees. Information about occupational conditions has not been analyzed in all studies of chronic LBP patients, which is probably the main reason that personality traits and depression have been seen to be of such importance in relation to chronic LBP. It might also be that factors such as depression are more important among individuals with more severe LBP.

Depression was not found to be a predictor for either ILBP or CLBP among women, but was reliable for CLBP among men. When inadequate coping strategies was included as a variable in the multivariate analysis of CLBP among men, depression did not remain in the model. This was because inadequate coping strategies (box 9) acted as a confounder, i. e. it was a risk indicator for CLBP as well as a correlate of depression in 1993. Physical factors at work were associated with ILBP and CLBP among men. Even though psychosocial factors at work were reliably related to both ILBP and CLBP, physical factors seemed to be the more important factors among men. The opposite was true for women. This may suggest that there are different mechanisms for the development of low back pain between the two genders. Alternatively, we may not have collected the relevant information about physical working conditions for women. For example, many occupations dominated by women are characterized by the frequent lifting of small burdens, rather than the occasional lifting of heavy burdens often seen among men. The intensity of the reported occupational factors may also differ between the genders, as was mentioned above in connection to study 4.

Vulnerability, specific and unspecific risk factors

Many of the psychosocial factors under study can be seen as unspecific demanding factors (i.e. factors that relate to several outcomes), rather than specific. Such conditions are heterogeneous and can be predictors for several outcomes, and one outcome can have several predictors (Öhman & Magnusson 1987). Also many of the non-occupational factors from family- and leisure-time

have the same characteristic. If an individual is exposed to several unspecific demanding factors, sudden exposure to one specific factor as, for example, heavy lifting may be a trigger for low back pain, although it is the exposure to the many unspecific factors that have made the individual vulnerable. Formative and triggering events have also been discussed in this context, where formative events increase the probability of future poor health, and triggering events, although leading to an episode of poor health, do not increase the probability to future poor health (Öhman & Magnusson 1987). Formative events will therefore be more important than triggering events, since they increases the vulnerability for poor health and promote an episode of poor health that otherwise might not have occurred. Socioeconomic status has been shown to be important in this context (Arve-Parés 1998; Hallqvist 1998). A reasonable hypothesis is that gender is another important factor. Social support have in various studies been shown to act like a buffer in relation to different outcomes, and very much so in relation to cardiovascular diseases (Lindelöw & Bildt Thorbjörnsson 1998). It has also been shown that men, in general, have fewer close friends that they can turn to when they have problems, which may increase their vulnerability to various disorders. In the present thesis, conditions related to poor social support at work and during leisure-time were related to LBP more markedly among men than among women, which supports that hypothesis. On the other hand, women may be more vulnerable than men because of larger total workload and conflicting demands from work and family, a hypothesis that is also supported by the results in the present thesis.

Concordance between findings

The findings in study 1, 3 and 4 in the present thesis correspond well with findings in other studies. High physical load in study 1 and heavy physical load in study 3 (both indices that included heavy lifting) among both genders, lifting among men in study 4 and among women with low educational level in study 4 were found to be risk indicators for LBP. In concordance, heavy lifting has been found in other studies to be reliably related to LBP (Frank et al 1996a; Vingård 1999). The same can be said about whole body vibrations, related to LBP among men in study 1, 3 and 4, and to LBP among women in study 1 (not reported because of the low number of exposed participants in 1969), in study 3, and among women with low educational level in study 4. High perceived workload, not included in study 1, was related to LBP among both genders in study 3 and 4, and in interaction with shift work with LBP among both genders in study 3. Low influence over work conditions was related to LBP among women in study 3, as was job strain (where low influence is included) in study 4. Lack of control over the work situation have in other studies been found to be reliably related to LBP (Frank et al 1996a; Vingård 1999). Monotonous work, found to be reliably related to LBP in other studies, was related to LBP among women and tended to be related to LBP among men in study 1. Shift work was related to LBP among women in both study 3 and study 4.

Methodological considerations

Generalizability

The eligible study group in 1993 differed very little from the general population in Stockholm, regarding income and socioeconomic conditions. Larger differences were found in the comparison with the general population in Sweden, probably because the industrial structure in Stockholm differs from that in the rest of Sweden. In Stockholm, there is less manufacturing and more knowledge-intensive industry.

The main impression from the analyses in study 5 was that there are characteristics that differ between the participants and the dropouts. The dropouts in 1993 had lower education and lower income than the participants, especially so among women. The dropouts had more self-reported musculoskeletal problems than the participants but less sick leave, probably because fewer of them were gainfully employed. They had also, in some respects, poorer health than the participants. Very few differences in occupational conditions and musculoskeletal health in 1993 were found between dropouts and participants in 1997. The observed differences between the participants and the dropouts had a very modest influence on the ratio estimates in the weighted analyses, which might be reassuring (if these results can be generalized) since many intervention actions have been outlined from findings in studies where very limited data about the characteristics of the dropouts have been available. Systematic bias because of differences between participants and dropouts did not seem to be present. However, it is possible that the influence on the ratio estimates would have been different if the attrition rate had been larger than in the present study.

One reason for the modest influence on the ratio estimates may be that individuals drop out from the study for a variety of reasons, most of them not at all connected to the studied variables. Reasons like temporarily residing abroad, having much to do at work or demanding family obligations were indicated in the self-reported reasons for not participating in the follow-up in 1993. Already at the base-line examination, reasons like these were given for nonparticipation (Bygren 1974). In studies of, for example, psychological stress and type A behavior, such differences between participants and dropouts may influence the results.

Applicability of the data collection methods used

The present results suggest that reliable information about psychosocial work conditions could be retrospectively collected by means of an interview in which earlier conditions were compared to the present ones. Most of the studied risk factors showed satisfactory or excellent reliability for present conditions and at three or four of the earlier points in time. The risk of over-reporting exposure was considered low for most of the examined risk factors if the exposure values taken from the job exposure matrix were close to the true criterion. Factor analyses allowed construction of two stable and meaningful indices covering concepts that conform to well-established risk factors for adverse health outcomes, i.e. psycho-

logical job demand and decision latitude, and social support at work (Karasek & Theorell 1990).

A crucial point in collecting data about retrospective psychosocial working conditions is to define the meaning or type of psychosocial working conditions, both for the participants and the interviewer/researcher. Two main approaches can be chosen. One approach has the focus on the more objective, or actual, working conditions that the participants have experienced in the past, and the other approach is focused on the individual's subjective experiences of the working conditions. What approach one should choose as a researcher depends on what hypothesis one has about associations between the psychosocial working conditions and the health outcome in question, and also what the aims of the study are. If the goal of the study is to intervene at a work place using a broad approach, the more objective aspects of the psychosocial working conditions are what should be studied. If the goal instead is to intervene on an individual level, it may be more beneficial to study the subjective aspects. If the more objective aspect is in focus, the aim of the interview is to give as accurate a description of the psychosocial working conditions as possible, without searching for consensus between the interviewer and the participant. If the subjective experience is in focus, the interview aims for consensus between the interviewer and the participant regarding the participant's past experiences of the psychosocial working conditions. In the present study, the distinction between the two approaches was probably not clear enough for work satisfaction and monotonous work, thereby explaining the poor inter-rater reliability. Monotonous work is especially complicated to define since it, among other things, can include repetitive work tasks and degree of boredom with work tasks, as could be seen in study 2. If no clear distinction between the two approaches has been made by the researchers, a low inter-rater reliability is very likely. To allocate much time for this step in the data collection process would therefore enhance the quality of the collected data about psychosocial working conditions.

Starting with the most recent event has been suggested as a way of improving the ability to place an event correctly in time (Bradburn, Rips & Shevell 1987). Aided recall, where the interviewer puts target events in context, can also promote correct recall (O'Doherty & Davies 1987; Reiser, Black & Abelson 1985). Phrasing the answers to the retrospective questions in terms of "better or worse than today", rather than trying to answer according to an absolute scale for each year under study, has been suggested as another useful way of enhancing data quality. This was done in study 2 and was found to work out satisfactorily.

Criteria for low back pain

We had somewhat different criteria for defining LBP in the studies. In study 1, the criterion for LBP in 1969 was reports of pain. In the follow-up in 1993, we tried to facilitate the recall of episodes of LBP by sharpening the definition criteria for LBP when collecting the retrospective data, and seeking medical care and sick-leave were therefore chosen as indicators of LBP during 1970-1993. The use of

these criteria defines LBP as being of a degree that probably resulted in a marked effect on daily life. In this way it was hoped that the participants' ability to recall episodes of LBP during the investigated period would increase. Under-reporting of LBP is therefore probably not differential regarding exposure to the studied risk factors. In study 3, some of the cases were defined by reported problems during the twelve months before the follow-up in 1993, and it can be presumed that there were differences in the pattern of risk indicators between participants classed as cases according to different definitions (i.e. visits to care providers, sick leave and reports of pain), resulting in a dilution of the ratio estimates. However, in this study, this effect is not thought to be of any major significance because of the small number of cases defined on the basis of other information than visits to care providers.

Sources of bias and limitations

The results in study 2 suggested that reliable information about psychosocial work conditions could be retrospectively collected by means of an interview in which earlier conditions were compared to the present ones.

Recall bias because of poor health was mentioned in the introduction. At the 1969 examination, information about a large number of physical and psychiatric symptoms was recorded, as well as information about the conditions at work and during leisure-time, and the interviews and clinical examinations were conducted by different researchers. The physiotherapist who conducted the clinical interview about musculoskeletal symptoms in 1993 was unaware of the participants' occupations and potential risk indicators. Information about musculoskeletal symptoms during the period 1970-92 was collected by means of a questionnaire. The risk for a differential misclassification regarding the outcomes in 1993 and 1970-92 was considered small. The risk of misclassification of both outcome and potential risk indicators is thus most probably non-differential (i.e. misclassification of outcome not related to exposure, and vice versa) and would introduce a bias towards unity for the different measures of associations used in the present study. If anything, an under-reporting of symptoms could be expected, which would introduce a bias towards lower measures of associations, if not differential.

In the REBUS-93 study, information regarding exposure conditions in 1969, collected in 1969 and in 1993, has been compared (Köster et al 1999). The results of these comparisons showed that participants who reported low back symptoms or neck/shoulder symptoms in 1993 reported their physical exposure to some of the work-related risk indicators in 1969 in more reliable terms, than did participants without symptoms, e.g., the participants with symptoms in 1993 better recalled their earlier exposure. It was also found that participants who were still exposed to the risk indicators reported exposure to the risk indicators in 1969 in more reliable terms (i.e., the sensitivity was higher). This was not true for all of the studied risk indicators, and there were also differences between the outcomes. The main conclusion drawn from the above-mentioned study was that ratio estimates were only slightly reduced and that the consequences for association

analyses did not seem serious. Another conclusion was that some of the retrospective risk indicators should not be used when measuring small effects. Presumably, the question about differential misclassification of different retrospectively assessed information about risk indicators will have to be discussed for each separate outcome (in relation to analyses of associations).

The longitudinal design of study 4 prevented misclassification of exposure because of ill health at the time of the collection of the exposure information, at least where ILBP and depression were concerned. The CLBP cases of course already had low back pain in 1993, which may have influenced their reports of working conditions. The information about psychosocial working conditions, physical working conditions, non-occupational factors and about low back pain, were collected by different researchers, in the hope that it would reduce this source of misclassification.

The quality of the data is crucial when one must rely on retrospectively collected information about both the studied factors and health outcomes, as in study 3. In the REBUS study in 1993, the test-retest reliability after two weeks and after one year of the questions concerning physical work conditions during 1970-1993 was found to be good and relatively stable over the two decades (Torgén et al 1997). Intraclass correlation coefficients ranged from 0.66 to 0.82 in the examination of the one year test-retest reliability. The validity of the same questions was examined in another study group against questions and measurements made six years earlier (Torgén, Alfredsson & Kilbom 1999). For most of the questions the validity was sufficiently high to be used in analyses of associations between physical workload and musculoskeletal health, with Spearman rank correlation coefficients from 0.5 to 0.8. The high reliability of the questions concerning physical conditions is probably a result of the design of the questionnaire, where the questions were anchored to the participants' occupation at different time periods, unlike another Swedish study, in which the test-retest reliability for similar questions was markedly lower (Wiktorin 1995).

The quality of the retrospectively assessed outcome data within the REBUS study has been examined in various ways. To estimate the validity of reported sick leave, the registered sick leave, analyzed in another study of REBUS material (Fredriksson et al 1998b), was reanalyzed. Registered sick leave was only available for four years (1990-1993) of the studied time period and only for those individuals in the study population who still lived in Stockholm in 1993. Among those, 120 controls and 142 cases from the present study were included. The validity of self-reported sick leave could thus be examined for these four years and for a part of the study group. In the reanalysis, the occurrence of registered sick leave among the controls, and the concordance between self-reported and registered sick leave among the cases during 1990-1993 were examined. Most cases were defined by medical consultation and only three of the 142 cases reported sick leave during these four years, but all of them also had registered sick leave because of low back pain. Only two of the 120 controls (2%) had registered sick leave because of low back pain. These results support our assumption about

the sufficient reliability and validity of the self-reported sick leave. Sick leave is one of the sources of information about low back pain in study 3 and it is reassuring to know that a significant degree of misclassification is unlikely.

The test-retest reliability of the questions about physical load during leisure-time showed a need for revision, except for the item about perceived load outside work (analyzed in the present study), which had an intraclass correlation coefficient value of 0.5 (Torgén et al 1997). The reproducibility, intraclass correlation coefficients, of the questions about physical exercise of medium and high intensity ranged from 0.5 to 1.0, and for the question about low intensity training from 0.2 to 0.5.

The main impression from all these analyses of data quality was that the reliability of the information collected was satisfactorily high and that the results in the present study were not heavily biased by over-reports of harmful conditions or outcomes.

Other possible sources of error in recalling earlier working conditions may, as mentioned in the introduction, include the frequency of the recalled event, the emotional content of the event, and a tendency to place events more recently in the time than they actually occur-red. None of these biases are likely to be outcome-dependent and they are all expected to result in non-differential error.

The main conclusion from these studies was that retrospectively assessed information about exposure and outcome can be used in epidemiological studies, but may introduce a non-differential bias, influencing the ratio estimates towards null.

The study population in the present thesis was drawn from the general population, which is both a strength and a weakness. Because of this, we have an opportunity to study potential risk indicators in a variety of occupations. But, also because of this, the contrasts between exposure groups are less marked, and therefore the ratio estimates may be lower than in studies where highly exposed groups are contrasted with low exposed groups.

New aspects in this thesis

Interactions between various occupational conditions, and between various occupational and non-occupational conditions have been shown to have effects on low back pain. The inclusion of information about non-occupational conditions and about depression proved valuable. A reliable method for retrospective assessment of psychosocial working conditions has been developed and evaluated. Differences between participants and dropouts were found, but the influence of these differences on the ratio estimates was modest. The systematic gender approach in the thesis revealed differences in risk indicator pattern among women and men, although the reasons for these differences could not be analyzed since no information about organizational or societal phenomena was collected in the REBUS study.

And the future?

Further studies, where information about occupational and non-occupational conditions, physiological stress markers, and about organizational and societal phenomena are included in the same analysis are needed to deepen the understanding of some of the findings in the present thesis. Gender, as well as ethnicity, socioeconomic status and level of education are important analytic concepts in these studies. Factors that buffer the effects from conditions on and off work also need to be studied.

Summary

Carina Bildt Thorbjörnsson. A quarter century perspective on low back pain: A longitudinal study. *Arbete och Hälsa* 1999:8.

The focus of this thesis is analyses of associations between occupational and non-occupational conditions on the one hand, and low back pain on the other. Methodological aspects of assessment of information about psychosocial working conditions, as well as of consequences of attrition in longitudinal studies, have also been examined.

The study group consisted of a group of individuals, drawn from the general Swedish population and examined in 1969 (783 participants), who were followed up in 1993 (484 participants) and in 1997 (420 participants).

When data concerning psychosocial and physical conditions and low back pain (LBP) from the base-line examination in 1969 were analyzed, work-related factors had a long-term effect mainly in interaction with leisure-time factors.

A method for retrospective collection of information about psychosocial work conditions was developed and evaluated. Inter-rater reliability and the agreement between self-reported and inferred exposure to various demanding psychosocial conditions at work were analyzed. It was possible to retrospectively and reliably assess information about psychosocial work conditions for a long period of years, when an individual time ruler was used in a structured interview, in which earlier conditions were compared to the present.

Information about the physical and psychosocial working conditions and low back pain during 1970-1993 was collected retrospectively, and analyzed with a nested case-control design. Forty-six percent of the participants became cases of LBP during the 24 years. Psychosocial and physical factors at work were seen to be risk indicators for LBP among both genders. Low influence over work conditions among women and poor social relations at work among men, in combination with other factors, seem to be of high relevance for the occurrence of low back pain.

When depression was added to physical and psychosocial factors at work and during leisure-time as potential predictors for incident (ILBP) and chronic low back pain (CLBP) among women and men, a number of physical, and several non-occupational, factors were associated with ILBP and CLBP among men, and a number of occupational psychosocial factors with ILBP and CLBP among women. Depression in 1993 was not a predictor for ILPB or CLBP in women, but was associated with CLBP among men.

The consequences of attrition in a longitudinal study of musculoskeletal disorders and occupational risk factors were examined. There were differences, mainly consisting of a somewhat lower educational level and lower income level among the dropouts, were found in the analyses of difference between participants and dropouts, and these resulted in increased or decreased ratio estimates of 0.1-

0.2, with the exception of overtime work among men, where the decrease was 0.4-0.5.

Further studies, where information about occupational and non-occupational conditions, physiological stress markers, and about organizational and societal phenomena are included in the same analysis are needed to deepen the understanding of some of the findings in the present thesis. Gender, as well as ethnicity, socioeconomic status and level of education are important analytic concepts in these studies. Factors that buffer the effects from conditions on and off work also need to be studied.

Key words: Interactions, occupational, non-occupational, interview method, retrospective, reliability, gender, chronic and incident, panel study, non-response.

Sammanfattning (summary in Swedish)

Carina Bildt Thorbjörnsson. A quarter century perspective on low back pain: A longitudinal study. *Arbete och Hälsa* 1999:8.

Avhandlingen fokuseras på samband mellan arbetsförhållanden, villkor på fritid och i familjelivet, och ländryggsbesvär. Även metodologiska frågor som berör retrospektiv datainhämtning av information om psykosociala arbetsförhållanden och betydelsen av bortfall i epidemiologiska studier har studerats.

Studiegruppen består av ett befolkningsurval som undersöktes första gången 1969 (783 personer), och som följdes upp 1993 (484 personer) och 1997 (420 personer).

Datanalyserna av relationen mellan psykosociala och fysiska arbetsvillkor, samt familje- och fritidsförhållanden, 1969 och ländryggsbesvär 1969-1993 visade att arbetsrelaterade faktorer 1969 hade en långsiktig påverkan på ländryggsbesvär framför allt i interaktion med familje – och fritidsförhållanden.

En metod för retrospektivt inhämtande av information om psykosociala arbetsförhållanden utvecklades och utvärderades. Interbedömar-reliabiliteten och överensstämmelsen mellan självrapporterad och uppskattad exponering för vissa påfrestande psykosociala arbetsförhållanden undersöktes. Huvudresultatet var att det var möjligt att inhämta pålitlig information om tidigare psykosociala arbetsförhållanden med hjälp av en individuell tidslinjal i en strukturerad intervju där tidigare arbetsförhållanden jämfördes med nuvarande.

Retrospektivt inhämtad information om psykosociala och fysiska arbetsförhållanden och ländryggsbesvär under 1970-1993 analyserades med en “nested” fall-kontroll-design. Arbetsrelaterade psykosocial and fysiska faktorer var relaterade till ländryggsbesvär hos både kvinnor och män. Lågt inflytande över arbetsförhållandena för kvinnor och dåliga sociala relationer för män var, i kombination med andra faktorer i och utanför arbetet, viktiga för utvecklandet av ländryggsbesvär.

När depression, tillsammans med psykosociala och fysiska arbetsfaktorer och familje- och fritidsfaktorer 1993, inkluderades i sambandsanalyserna var ett antal fysiska faktorer och familje- och fritidsfaktorer relaterade till nytillkomna och långvariga ländryggsbesvär 1997 hos män, och ett antal psykosociala arbetsfaktorer till nytillkomna och långvariga ländryggsbesvär 1997 hos kvinnor. Depression 1993 var inte relaterad till ländryggsbesvär hos kvinnor, men till långvariga ländryggsbesvär hos män.

Betydelsen av bortfall i en longitudinell studie av rörelseorganens sjukdomar undersöktes. Det var skillnader mellan deltagare och bortfallspersoner, och de bestod till största delen av att bortfallspersonerna hade något lägre utbildning och inkomst, samt något sämre hälsa. Dessa skillnader påverkade riskestimaten i

sambandsanalyserna med 0.1 eller 0.2 i båda riktningarna, med undantag för övertidsarbete, där minskningen var 0.4-0.5.

Vidare studier, där information om psykosociala och fysiska arbetsförhållanden, familje- och fritidsförhållanden, fysiologiska stressmarkörer, organisationsförhållanden och samhällsförhållanden läggs in i samma analys är nödvändiga att göra för att mera i detalj förklara en del av fynden i denna avhandling. Kön, liksom etnicitet, socialgrupp och utbildningsnivå är i dessa vidare studier viktiga analytiska koncept. Även faktorer som skyddar mot skadliga effekter av påfrestningar i och utanför arbetet behöver studeras.

Nyckelord: Interaktioner, yrkes- och icke yrkes-relaterat, intervjumetod, retrospektiv, reliabilitet, kön, kronisk och incident, panelundersökning, bortfall.

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Appendix 1

In the 1969-70 study, data concerning psychosocial and physical variables at work and leisure time were collected by a questionnaire-based interview. All answers are on a dichotomous scale and an affirmative answer to a question is most often synonymous with exposure. In those cases where a negative answer is synonymous with exposure, these questions are marked with a * (or has a parenthesis at the end of the sentence). Answers on a dichotomous scale for 11 work related exposure variables were grouped into eight types of exposures.

1) Physical load: Do you need to be able to lift 40/60 kg (women; 40, men; 60) in order to manage your work? or Do you often feel physically exhausted in the afternoons after work?

2) Mental load : Is your work hectic? and Do you often feel mentally exhausted in the afternoons after work?

3) Poor social support at work: *Is it possible for you to discuss work related problems with your closest superior? or *If it is, is your opinion taken into consideration?

4) Whole body vibrations: Are you in your work exposed to intense shakings or vibrations?

5) Monotonous work: Is your work monotonous?

6) Full/part time work : Do you work full time?

7) Night or shift work: What are your working hours? (exposure = working shift or working nights).

8) Working overtime: Do you work overtime more than one hour per week?

Six exposures during non-working hours, also on a dichotomous scale, were analyzed and grouped into three types of exposures.

9) Unsatisfactory leisure time: *Do you have any time outside work when you can relax and do activities that you want to do? or *Are you satisfied with your leisure time?

10) Unsatisfactory social contacts: How often do you have contact with your friends or relatives (exposure : when the subject once a month, or more rarely, has contact with friends or relatives) or *Are you satisfied with that contact?

11) Gainfully employed as well as responsible for the children and the household: Do you have two jobs? (both paid work and unpaid work at home?) and Do you have children under 18 years of age living at home?

Socioeconomic groups were determined on the basis of the subject's occupation in 1969-70 and were roughly divided into white or blue-collar worker groups.

Appendix 2

Questions about the psychosocial working conditions in 1993, answering alternatives, and levels where the variables were dichotomized. Levels indicated within parenthesis indicate the cut-off between not harmful and potentially harmful levels.

General working conditions

1) Shift work: What working hours do you have? Seven alternatives from daytime to night work (day time, all other working hours).

2) Overtime work: Do you work overtime? Five alternatives from not at all to much (some or less, rather much or much).

Commitment and satisfaction

3) Low commitment to work tasks: Are you committed to your work tasks? Five alternatives from very much to not at all (very or rather much, some or less).

4) Low commitment to social aspects of work: Are you committed to the social part of work? Five alternatives from very much to not at all (very or rather much, some or less).

5) Low commitment to colleagues: Are you committed to your colleagues? Five alternatives from very much to not at all (very or rather much, some or less).

6) Low work satisfaction: Are you satisfied with your working conditions? Five alternatives from very much to not at all (very or rather much, some or less).

Work contents

7) Few demands of new knowledge: Do you need to gain new knowledge now and then to manage your work tasks in a good way? Four alternatives from very much to not at all (to some or high degree, to a little degree or less).

8) Low decision latitude: Do you have possibilities to decide when or how you perform your work tasks? Four alternatives from very much to not at all (to some or high degree, to a little degree or less).

9) Few development possibilities: Are there development possibilities in your work? Three alternatives from many to not at all (many or some, few or not at all).

10) Monotonous work: Do you regard your work tasks as similar during the working day? Three alternatives from yes to a certain degree to not much varying (to a certain degree, some or not at all).

11) Low influence over work pace: Is it possible for you to influence the work pace? Three alternatives from very much to only little or not at all (very much, some or less).

12) Time pressure: Do you work with time pressure on a regular working day? Five alternatives from 0% of the day to 100% of the day (less than 75%, 75% or more).

Interruptions and risks for accidents in work: What kinds of interruptions occur within your different work tasks?

13) Social interruptions (unclear instructions, people who disturb, phone calls that disturb, difficulties to reach the employer, and so on) Three alternatives from seldom to often (sometimes or seldom, often).

14) Technical interruptions (bad technical equipment, lack of working material, lack of personnel, too monotonous or too heavy work tasks, and so on) Three alternatives from seldom to often (sometimes or seldom, often).

15) Accident risks: How frequently is there a risk of accidents at work? Three alternatives from seldom to often (sometimes or seldom, often).

Social interaction

16) No dependence on help from colleagues: Are you dependent on your colleagues for managing your work tasks? Four alternatives from absolutely to not at all (to some degree or more, to a lesser degree or not at all).

17) Poor social support from colleagues: Do you receive the support you need from your colleagues to manage your work tasks? Four alternatives from absolutely to not at all (to some degree or more, to a lesser degree or not at all).

18) Poor social support from superior: Do you receive the support you need from your closest superior to manage your work tasks? Four alternatives from absolutely to not at all (to some degree or more, to a lesser degree or not at all).

19) Poor social interaction with colleagues after work: Do you socialize with your colleagues? Four alternatives from much to not at all (much, somewhat or less).

Appendix 3

Questions about the psychosocial working conditions in 1993, answering alternatives, and levels where the variables were dichotomized. The indices were dichotomized at the 75th percentile.

1) Shift work: What working hours do you have? Seven alternatives from daytime to night work (daytime, all other working hours).

2) Overtime work: Do you work overtime? Five alternatives from not at all to much (some or less, rather much or much).

3) Low commitment to colleagues: Are you committed to your colleagues? Five alternatives from very much to not at all (very or rather much, some or less).

4) Few demands of new knowledge: Do you need to gain new knowledge now and then to manage your work tasks in a good way? Four alternatives from very much to not at all (to some or high degree, to a little degree or less).

5) Low decision latitude: Do you have possibilities to decide when or how you perform your work tasks? Four alternatives from very much to not at all (to some or high degree, to a little degree or less).

6) Few development possibilities: Are there development possibilities in your work? Three alternatives from many to not at all (many or some, few or not at all).

7) Low influence over work pace: Is it possible for you to influence the work pace? Three alternatives from very much to only little or not at all (very much, some or less).

8) Time pressure: Do you work with time pressure on a regular working day? Five alternatives from 0% of the day to 100% of the day (less than 75%, 75% or more).

9) Technical interruptions (bad technical equipment, lack of working material, lack of personnel, too monotonous or too heavy work tasks, and so on) Three alternatives from seldom to often (sometimes or seldom, often).

10) Accident risks: How frequently is there a risk of accidents at work? Three alternatives from seldom to often (sometimes or seldom, often).

11) No dependence on help from colleagues: Are you dependent on your colleagues for managing your work tasks? Four alternatives from absolutely to not at all (to some degree or more, to a lesser degree or not at all).

12) Poor social support from colleagues: Do you receive the support you need from your colleagues to manage your work tasks? Four alternatives from absolutely to not at all (to some degree or more, to a lesser degree or not at all).

13) Poor social support from superior: Do you receive the support you need from your closest superior to manage your work tasks? Four alternatives from absolutely to not at all (to some degree or more, to a lesser degree or not at all).

14) Poor social interaction with colleagues after work: Do you socialize with your colleagues? Four alternatives from much to not at all (much, somewhat or less).

Appendix 4

Questions about physical conditions at work and answer alternatives. Level indicated within parentheses indicates cut-off points. The index was dichotomized at the 75th percentile.
1) Perceived general exertion: 6-20 where 7 is very, very light and 19 very, very hard. ($\leq$12).
2) Proportion of the day spent sitting: Continuous scale (20% or more per day).
3) Proportion of the day with whole body vibrations: Continuous scale (more than 1% per day, e g occurrence of vibrations or not).
4) Hands below knee level exceeding 30 minutes per day: Five alternatives from Almost never/not at all to Every work day (1 day per week or more).
5) Bent or twisted body postures several times per hour: Five alternatives from Almost never/not at all to Every work day (1 day per week or more).
6) Occurrence of lifting/carrying loads between 5 and 15 kg: Five alternatives from Almost never/not at all to Every work day (1 day per week or more).
7) Occurrence of lifting/carrying loads exceeding 15 kg: Five alternatives from Almost never/not at all to Every work day (1 day per week or more).

Question about physical conditions during leisure-time.
8) Perceived general exertion: 6-20 where 7 is very, very light and 19 very, very hard. ($\leq$12).

Questions about physical exercise and answer alternatives
9) Number of high intensity physical training sessions per week: Five alternatives from Not at all/very little to More than 3 times a week (Not at all).
10) Number of moderate intensity physical training sessions per week: Five alternatives from Not at all/very little to More than 3 times a week (Not at all).
11) Number of low intensity physical training sessions per week. Five alternatives from Not at all/very little to More than 3 times a week (Not at all).

The questions about physical exercise were exemplified; high intensity as running, biking, work-out, squash and so on during at least 15 to 20 minutes to a level where you get out of breath; medium intensity as jogging, biking, work out, dancing and so on during at least 15 to 20 minutes to a level where you became slightly warm; light intensity as walks lasting at least 30 minutes.

Appendix 5

Level indicated within parenthesis indicates cut-off points.

Physical working conditions
1) High perceived workload: 6-20 where 7 is very, very light and 19 very, very hard (≤12).
2) Proportion of the day spent sitting: Continuous scale (80% or more per day).
3) Proportion of the day with whole body vibrations: Continuous scale (more than 1% per day, e g occurrence of vibrations or not).
4) Hands below knee level exceeding 30 minutes per day: Five alternatives from Almost never/not at all to Every work day (1 day per week or more).
6) Bend or twisted body postures several times per hour: Five alternatives from Almost never/not at all to Every work day (1 day per week or more).
6) Occurrence of lifting/carrying loads between 5 and 15 kg: Five alternatives from Almost never/not at all to Every work day (1 day per week or more).

General working conditions
7) Full time work: How many hours a week do you work? Four alternatives from 1-19 to at least 35 hours (35 hours or more).
8) Overtime work: Do you work overtime? Three alternatives from not at all to often (often).
9) Shift work: What working -time do you have? Seven alternatives from daytime to night work (all other working-times than daytime).

Psychosocial conditions
10) Low occupational pride (index of four questions): Are your current work tasks stimulating? Do you feel safe and confident in your work? Do you think your work is valuable? Do you think that your work is valued by others? Four alternatives from not at all to very much. The index was dichotomized at the 75th percentile.
11) Job strain: High values in both high demands and low control. High demands (index on five questions): Does your work demand that you work very fast? Does your work demand that you work very hard? Does your work demand too great effort? Do you have time enough to do your work tasks? Are there any contradictory demands in your work? Four alternatives from almost never to very often. The index was dichotomized at the 75th percentile. Low control (index on two questions): Do you have possibility to influence how your work should be done? Do you have possibility to influence what work that shall be done? Four alternatives from almost never to very often. The index was dichotomized at the 75th percentile.
12) Few possibilities to gain new knowledge (index on four questions): Can you learn new things at work? Does your work require skills? Does your work require creativity? Do you have to do the same task over and over again? Four alternatives from almost never to very often. The index was dichotomized at the 75th percentile.
13) No education at employer's expense: Have you during the last 12 months had education at your employer's expense? Two alternatives, no or yes (no).

Individual factors

14) Low frequency of social contacts (index on four questions): How often do you meet and spend time together with, neighbors, colleagues, relatives and friends? Six alternatives from almost never to several times a week (Once per month or less on all four questions).

15) Poor quality of social contacts: Estimated from an interview about social contacts with relatives and friends in 1993 (not available for 1997). Five alternatives from very poor to good (rather superficial or worse).

16) Smoking: Are you a smoker? Three alternatives from yes habitual to not at all (yes habitual).

17) High perceived load outside work: Continuous scale from 6-20 where 7 is very, very light and 19 very, very hard. (<=12).

18) Poor coping strategies: Estimated from an interview about demanding life events and strategies used by the subject to solve the problems related to the life event in focus in the interview (not available for 1997). Five alternatives from schizoid to adequate (rather superficial or worse).