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On causes of neck and shoulder pain in the general population

Epidemiological studies on associations between workload and leisure-time activities, and disorders in the neck/shoulder region

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List of papers

This thesis is based on the following papers, which will be referred to by their Roman numerals

I Fredriksson K, Toomingas A, Torgén M, Bildt Thorbjörnsson C, Kilbom Å. Validity and reliability of self-reported retrospectively collected data on sick leave related to musculoskeletal diseases. *Scandinavian Journal of Work, Environment & Health* 1998;24(5):425-431.

II Fredriksson K, Alfredsson L, Köster M, Bildt Thorbjörnsson C, Toomingas A, Torgén M, Kilbom Å. Risk factors for neck and upper limb disorders: results from 24 years of follow-up. *Occupational and Environmental Medicine* 1999;56(1):59-66.

III Fredriksson K, Alfredsson L, Bildt Thorbjörnsson C, Punnett L, Toomingas A, Torgén M, Kilbom Å. Risk factors for neck and shoulder disorders. A nested case-control study covering a 24-year period. *American Journal of Industrial Medicine (In press)*

IV Fredriksson K, Ahlberg-Hultén G, Alfredsson L, Josephsson M, Kilbom Å, Wigaeus Hjelm E, Wiktorin C, Vingård E, MUSIC-Norrtälje Study Group. Work environment and neck and shoulder pain: the influence of exposure time. Results from a population-based case-referent study. *Submitted*

V Fredriksson K, Bildt Thorbjörnsson C, Hägg G, Kilbom Å. The impact on musculoskeletal disorders of changing physical and psychosocial work environment conditions in the automobile industry. *Submitted*

List of abbreviations

PR	prevalence ratio
CIR	cumulative incidence ratio
OR	odds ratio
RR	relative risk
CI	confidence interval
RPE	rating of perceived exertion
PEO	portable ergonomic observation method
VDT	work with visual-display terminals

Contents

Introduction

Focus of this thesis

Musculoskeletal diseases are common all over the world. However, due to methodological difficulties the prevalence estimates from different parts of the world may be difficult to compare. Efforts have been made to make an overview of the prevalence of self-reported upper limb disorders within the European Union (EU) (Buckle & Devereux, 1999) and it was concluded that "a substantial proportion of workers in the EU experience work-related musculoskeletal conditions that affect the neck and upper limbs". Reports of an increase in the amount of upper limb disorders during recent years have been published in the Nordic countries (Stockholms läns landsting, 1999; Lehto et al., 1999). A relation between different factors both inside and outside work and neck/shoulder musculoskeletal disorders has been described in many publications (Buckle & Devereux, 1999; Hagberg et al., 1995; Putz-Anderson et al., 1997). Most of those studies have a cross-sectional design or focus on specific areas of working life among workers who are highly exposed to specific factors, and have a high prevalence of neck and shoulder disorders (Kilbom et al., 1986; Ohlsson et al., 1994b; IASP 1994; Vihma et al., 1982). However, risk factors identified from such studies are highly unusual in most jobs, and neck/shoulder disorders are still very common in the general population. Thus studies on the aetiology of neck and shoulder pain in the population are needed, including both work conditions and leisure-time conditions. The focus of this thesis was to study how different work-related and non-work–related factors contribute to the incidence of neck and/or shoulder pain in the general population. The perspective is bio-psychosocial (Sivik et al., 1995), including both physical and psychosocial factors from work as well as from leisure-time.

The prevalence of neck and shoulder disease and disorders

Neck/shoulder pain and disorders are more prevalent among women than among men (Ekberg et al., 1994; Linton, 1990; Nordander et al., 1999) in all age groups and have been found to increase with age, both among women and men (Linton, 1990; Statistics Sweden, 1994; Tuomi et al., 1991). Even in the age group 42-58 years of age, the prevalence of neck/shoulder disorders was higher for those above 50 (Fredriksson et al., 1997). In a Swedish population-based case-control study, immigrant background was found to be associated with diseases in the neck and shoulders (Ekberg et al., 1994). While the prevalence of continuous aches and pains was stable from 1977 to 1997 regarding most body regions, a clear increase was seen with regard to neck pain among Finnish women and men (Lehto et al., 1999).

Due to considerable differences between countries in reporting and in definitions of upper limb musculoskeletal disorders it is difficult to get an overview of the problem in different countries and to make comparisons concerning the size of the problem. An overview of the prevalence of self-reported symptoms of musculoskeletal disorders within some EU member states has been published (Buckle & Devereux, 1999), showing great variations. Surveys can approximately measure the size of the problem. In a survey in the Netherlands, for example, 30.5% of a study population of 10,813 employees, representative for the industrial sectors in the Netherlands reported upper limb musculoskeletal disorders in the previous 12 months (Blatter et al., 1999a; Blatter et al., 1999b). The prevalence of self-reported neck or shoulder or arm pain after work every week was in Sweden approximately 20% among men and 33% among women (Statistics Sweden, 1994). Also in Great Britain the prevalence of upper limb musculoskeletal disorders was found to be high (Jones et al., 1998). The economic impact on society as a result of musculoskeletal disorders is high. In the U.S., the cost of occupational upper limb musculoskeletal disorders has been estimated by NIOSH to be $ 13 billion annually (Bernard, 1997). Despite differences it can be concluded that upper limb musculoskeletal disorders are quite common in most industrialized countries, causing much suffering also resulting in economically significant consequences.

Definitions of the concepts pain, disorder and disease in this thesis

Morbidity may be described by the different concepts: illness, disease and sickness. Illness is defined as self-reported bad health, disease as diagnosed ill health according to medical science, and sickness as the social role given the person suffering from ill health (Alexanderson, 1998). Regarding musculoskeletal bad health, *pain* is included in most morbidity. In the term *disorder* consequences of the pain in daily living are also included (sickness). *Disease* is used in this thesis only to describe morbidity where there is a medical diagnosis.

Pain is a common phenomenon, whatever definition is being used. The International Association for Study of Pain (IASP) has defined pain as an “unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage”(1994). According to Cailliet “pain can no longer be considered merely a symptom. It is currently considered to be a disease.” The interpretation of the concept of pain varies, depending on the evaluator’s speciality. While a psychologist defines pain as an emotional reaction to a physical insult, to an orthopaedist pain is the result of a musculoskeletal deviation (Cailliet, 1996).

Anatomy and function of the normal neck and shoulder joints

The biological and mechanical natures of the shoulder and neck region form the basis of function and also of malfunction. All different parts involved may be impaired and also affected by malfunction and pain.

The upper extremity functionally includes structures in the neck, the shoulder girdle, the upper arm, forearm, wrist and hand. Joints, ligaments, tendons, muscles and nerves are involved in most activities, and normally a well-coordinated and functional movement pattern is the basis for the upper limb movements of our daily lives.

The range of motion is high in the shoulder joint, and the arm depends upon soft tissues for support and function. Many joints are involved in the shoulder complex, as shown in figure 1-1. Some of them can be looked upon merely as functional joints, such as scapula's articulation upon the rib cage.

Figure 1-1

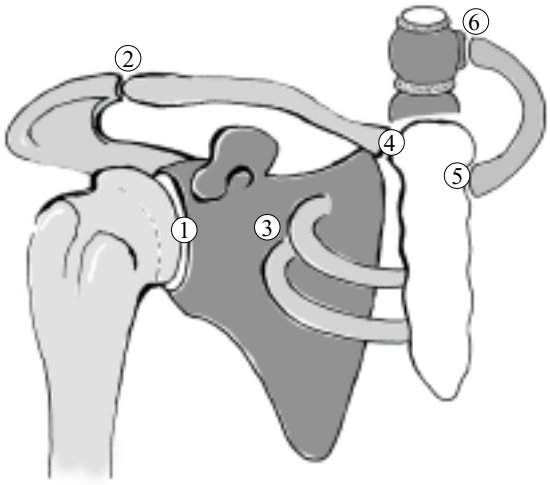

Figure 1-1. Schematic owerview of the joints of the shoulder girdle:
(1) glenohumeral,
(2) acromioclavicular,
(3) scapuloscostal,
(4) sternoclavicular,
(5) sternocostal,
(6) costovertebral

Figure 1-2

3Figure 1-2. The superficial muscles of the shoulder girdle:
(a) m occipitofrontalis
(b) m sternocleidomastoideus
(c) m trapezius
(d) m deltoideus
(e) m infraspinatus
(f) m teres major
(g) m rhomboideus major
(h) m latissimus dirsi

Numerous muscles are involved in the shoulder girdle function (figure 1-2), acting both as a passive support of the shoulder joint and as prime movers. All voluntarily activated muscles in the body have a coordination control exerted by the muscle spindle system, ensuring a smooth, coordinated neuromuscular function. The nerves from the cervical and the upper thoracic part of the spine supply the muscles of the shoulder girdle, and act as conductors for the nerve impulses, giving rise to voluntary movements.

Neck and shoulder pain

The different parts of the shoulder girdle may be injured for different reasons, leading to different types of impairment and pain. Violent external forces can lead to injuries in all tissues involved, while working life and leisure-time activities mostly harm soft tissue. As the neck and the shoulders form a functional unity it is mostly more meaningful in research work not to try to divide up symptoms from these regions. Moreover, a combination of questionnaire-based information, regarding neck and shoulder complaints, respectively, has been found to give more appropriate results than if the neck and shoulders are handled separately (Ohlsson et al., 1994a).

Diagnoses are valuable for treatment purposes, but for prevention and in epidemiological research, information as to whether or not a subject is suffering from pain and/or disorders is mostly enough. In a recent report the importance of considering musculoskeletal disorders without a specific diagnosis or pathology in health monitoring and surveillance systems has been emphasized (Buckle & Devereux, 1999).

Assessment of neck and shoulder pain and disorders

Pain is a subjective experience. Scientists try to achieve as reliable and valid measures as possible, and therefore self-reports have often been considered as less valuable than signs and symptoms revealed by medical examination. The natures of musculoskeletal diseases often have a fluctuating course, including periods of recovery and falling ill again (Frank et al., 1995). Therefore results from an examination can only tell about status on that particular day, which may be different from the status most days. If information about pain is not limited to a special occasion there might be a better chance to grasp the magnitude and meaning of the pain and disorder. There may also be no objective signs, even though the study person experiences pain and/or is disabled at work and/or during leisure-time, in which case a self-report will better mirror the situation.

Surveys based on self-reported pain have the advantage of capturing the pain, despite the fact that the studied persons are prevented from seeking, or choose not to seek medical care for different reasons, and before any consequences regarding working life or during leisure-time have occurred. The reason for using self-reports is also that such reports are easy to manage, especially if large groups are studied, and are cheap to collect. In a study comparing questionnaire-based

information with clinical examination, it was concluded that the questionnaire approach gives a fairly good picture of the neck/upper extremity status of a working female population (Ohlsson et al., 1994a). However, in another study physical examination was found to reveal higher prevalence of upper limb morbidity than questionnaire based information among men (Nordander et al., 1999).

Another outcome measure is visits to caregivers due to neck/shoulder pain. One reason for choosing visits to caregivers instead of self-reported pain is that if a person chooses to make the effort and pay the price to visit a caregiver, then the pain is not negligible and it has probably interfered with his/her life. The reason for not seeking care may be of a different nature. In some jobs it may be possible to work in spite of neck/shoulder pain. Other factors are whether the patient can afford care, whether it is easy to get appointments with caregivers, and whether it is common in the patient's social group to seek care for musculoskeletal pain. Persons with chronic or recurrent neck/shoulder pain might have sought care on previous occasions, but found that they got little or no help. Therefore they choose not to seek care this time in spite of the pain. Another reason for not seeking care may be that the patients have previously been given advice and training instructions, and therefore this time try to manage on their own. A reason for researchers to choose seeking care instead of self-reported pain in retrospective studies is that a visit to caregivers would possibly be easier to remember than experienced pain years ago.

Sick leave due to neck/shoulder pain may also be used as an outcome measure. However, the amount of sick leave is influenced by many different circumstances, such as financial loss, compensation rate and fear of losing the job or being passed over. In some jobs you may work with considerable neck/shoulder pain, while in others you have to take sick leave. In Sweden a person has to visit a doctor if sick leave for more than 7 days is needed. If reports of sick leave have to be self-reported retrospectively, due for example to a big time span, it is likely that the sick leave would be better remembered if a visit to a doctor was also paid.

In spite of the reservations mentioned, sick leave and visits to caregivers may be useful as a measure of neck/shoulder pain, especially if the aim is to study serious pain. Since data regarding sick leave is registered, validation of data regarding self-reported sick leave may also be possible. Different kinds of outcome measures will give different figures, but it is not evident which is the "true" one. They will merely show different sides of the problem (Alexanderson, 1998).

Effect of physical and psychosocial stressors on musculoskeletal tissues

Both work-related and non-work-related conditions are dealt with in this thesis. Most research regarding mechanisms and possible pathways between physical and psychosocial stressors have been performed on work-related issues. The expert panel involved in the National Research Council, 1999, have provided an overview concerning possible pathways for how work-related factors act on soft tissues. No single common such pathway for all exposures could be recognized. Mechanisms involved have not yet been determined for each disorder, but

plausible hypotheses are put forward when documented mechanisms could not be presented (NRC, 1999). Since the main focus in this thesis is the neck and shoulder region, it is mainly theories about mechanisms for pain and disorders in this region that will be discussed. Hypotheses about overuse of certain muscle fibres as a result of stereotype recruitment patterns, the so-called “Cinderella syndrome”, have been suggested (Hägg, 1991). A review of the literature suggests that mitochondrial disturbance in certain muscle fibres is a result of static and/or repetitive workload in the upper trapezius muscle (Hägg, 2000). It is also evident that some aspects of psychological stress can cause static activation on the trapezius muscle (Melin et al., 1997; Waersted et al., 1996). Another hypothesis is that stress creates physiological changes that increase the vulnerability of the musculoskeletal system in general (Theorell, 1996). Damage of tendons and ligaments may especially occur as inflammations when these tissues are loaded over long periods of time in awkward postures, or at the end of range of motion (Armstrong et al., 1984). Experimental studies have provided evidence that repetitive loading of the tendon can induce histological changes (Backman et al., 1998). The most common symptom of musculoskeletal disorders in the neck/shoulder region is muscle pain (Sjogaard, 1990), but stiffness and tenderness in the tissues is also common. Increase in the sensitivity of injured tissues (sensitisation) has been observed in clinical cases among patients with persistent and ongoing musculoskeletal problems (Besson, 1999; Blair, 1996). The explanation these authors give is that a continued release of inflammatory chemicals triggers the release of inflammatory mediators, which activates the type of peripheral nerves that carry pain signals to the central nervous system. Hypotheses about increased activity in the muscle spindle system, due to repeated physical exposure creating a “vicious circle” of adjacent muscle stiffness in the neck/shoulder region, and thereby preserving or increasing the production of metabolites and the high activity in chemosensitive nerve endings, have been proposed by Johansson and Sojka (Johansson et al., 1991). Spread of muscle tension to surrounding muscles (Johansson & Sojka, 1991; Wennergren et al., 1998) and altering of muscle coordination from inflammatory processes has also been found (Bergenheim et al., 1995).

The relationship between physical and psychosocial factors and neck and shoulders disorders

Models of associations

The National Research Council of USA has presented a model where non-work-related activities and individual factors, as well as different factors from work and factors related to the social context, are included (NRC, 1999), (fig 2).

Several other models about how different factors, mostly from work, are presumed to be associated with musculoskeletal disorders have been presented. Winkel and Mathiassen suggest that regarding mechanical exposure both level, repetitiveness and duration should be taken in consideration (Winkel et al., 1994). Dutch researchers have also included the actual working methods and work

capacity in their models (van der Beek et al., 1998). A model of how exposure may act upon tissues of the body over time to create various physiological and biomechanical effects, explaining the cumulative nature of upper limb disorders, has also been presented (Armstrong et al., 1993). The different models show considerable agreement, and together they provide a useful basis for understanding both the pathogenesis and the relationship of these disorders (Buckle & Devereux, 1999).

Work-related factors found to be associated with neck and shoulder pain and disorders

Based on earlier epidemiological studies the situation regarding associations between work-related factors and neck/shoulder pain and disorders can be summarised as follows with different degrees of support for a causal relationship:

1. There seems to be a causal relationship between repetitive work, defined as continuous movements involving arms or hands, and neck/shoulder musculoskeletal disorders (Chiang et al., 1993; Ekberg et al., 1994; Kilbom, 1994; Ohlsson et al., 1995; Onishi et al., 1976; Rossignol et al., 1987). There is also evidence supporting a causal relationship regarding extreme or static posture (Kilbom et al., 1986; Ohlsson et al., 1995; Punnett et al., 2000). Regarding work role ambiguity, rushed work pace, poor work content and light lifting (Ekberg et al., 1994) and perceived high workload (Josephson et al., 1997), results from a few case-control studies lend some support to a causal relationship.
2. There is insufficient evidence to provide strong support for a relationship between vibration and neck/shoulder disorders (Putz-Anderson et al., 1997; Viikari-Juntura et al., 1994).
3. In the epidemiological literature an association between forceful exertion and occurrence of neck/shoulder disorder can be found. Forceful exertion is defined as work activities involving forceful arm and hand movements (Aarås et al., 1988; Veiersted, 1994; Viikari-Juntura et al., 1994). Associations regarding monotonous work, time pressure and poor social support at work (Bongers et al., 1993), opportunity to influence decisions (Theorell et al., 1991), work pressure (Sauter et al., 1993) as well as boredom, stress and lack of variety and work satisfaction (Hopkins, 1990) have been observed in cross-sectional studies.
4. Combinations of physical risk factors have been found to increase the risk of hand/wrist tendinitis (Putz-Anderson et al., 1997). Regarding neck/shoulder pain, combinations of physical and psychosocial factors gave an increase in odds ratios in cross-sectional studies (Brulin et al., 1998; Linton, 1990.; Punnett, 1998). The effects of combinations of factors on the incidence of neck/shoulder pain, also considering non-work-related factors, need to be further studied.
5. The impact of the length of exposure time has earlier been investigated as years of employment in some specific jobs (Andersen et al., 1993; Hägg et

al., 1990; Kamwendo et al., 1991). It was found that the prevalence of neck/shoulder disorder increased with increasing length of employment. Further studies are needed in order to determine whether these results are also true for other jobs, and whether the incidence of neck/shoulder pain increases with rising exposure time, regarding different work-related and non-work-related conditions not linked to special jobs.

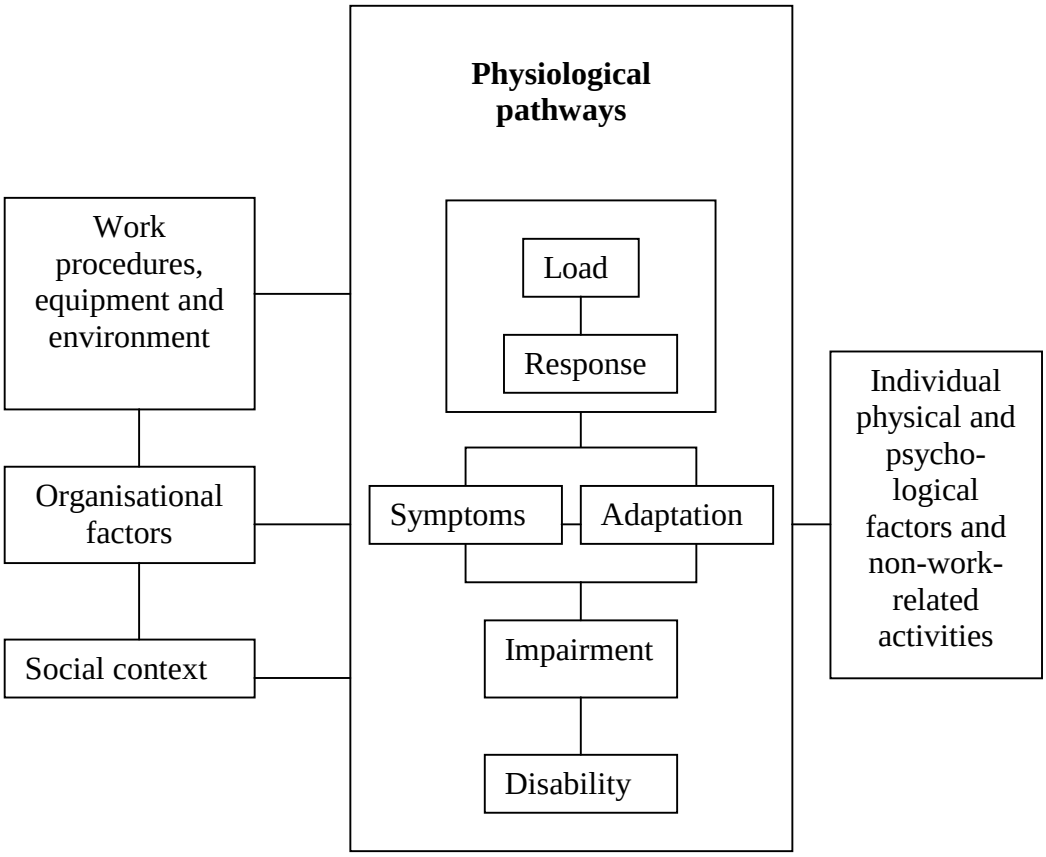

Figure 2. Conceptual framework of physical pathways and factors that potentially contribute to musculoskeletal disorders (National Research Council, 1999, with permisssion)

Other factors

The labour market in Sweden is gender-segregated. Women often experience lack of influence over working conditions, and many jobs where mostly women work include monotonous and repetitive work tasks. Even at the same workplace women more often than men work with repetitive and unskilled tasks (Kilbom et al., 1998). Torgén and Kilbom found that “between 1970 and 1993 the fraction of subjects in blue-collar physical occupations and physical workloads decreased among men, but they both increased among women. Physical workloads were in general higher among men than women at younger ages (below 30 years), but less so at higher ages” (Torgén et al., 2000).

Sixty-two per cent of the employed women and 90 % of the employed men in Sweden work full-time (Westberg, 1998). However, even among couples where both the woman and the man are working full-time, the women have the main responsibility for the home and the children, and spend approximately 10 more hours a week on household duties than their spouse (Lundberg et al., 1994). It is reasonable to assume that the health of employed women is influenced both by the paid and the unpaid work, and the balance between professional, family and leisure-time (Barnett et al., 1991; Josephson, 1998). Due to the differences in the total life situation for women and men it is suggested that analyses regarding associations between work and leisure-time conditions and musculoskeletal pain and disorders should be made separate for the genders.

In a study of chronic neck pain in a population sample in Finland it was found that smoking represented a relative risk of 1.3 (95% CI 1.03-1.61) (Mäkelä et al., 1991). Also in other studies, smoking has been found to be slightly associated with neck/shoulder disorders (Barnekow-Bergkvist et al., 1998b; Ekberg et al., 1994; Holmström et al., 1992; Linton, 1990.), but the association between smoking and incidence of neck/shoulder disorders has to be further investigated.

Physical inactivity has not been found to be associated with neck/shoulder disorders in earlier studies (Barnekow-Bergkvist et al., 1998a; Ekberg et al., 1994; Linton, 1990.). However, high performance in adulthood in hand-grip strength and good flexibility in the neck among women was found to be associated with a decreased risk of neck/shoulder problems (Barnekow-Bergkvist et al., 1998a). Kilbom (1988) also found a significant correlation between decreased neck disorders and isometric strength in women with heavy dynamic jobs, but not in those with light repetitive jobs. Thus there are reasons to include physical activity during leisure-time in studies about incidence of neck/shoulder pain and disorders.

Individual vulnerability for neck/shoulder pain due to heredity, coping strategies and earlier life events may be of importance for the risk of becoming ill, but these factors have only been studied to a limited extent in connection with neck/shoulder pain.

Research challenges arising from the changes in working life

The rapidly changing conditions in today´s working life and the increase in worker mobility present new challenges to researchers. The dynamic change in starting position does not permit long-term follow-ups, and participation of target populations and enterprises is becoming more difficult to arrange (Rantanen, 1999).

Earlier studies on neck/shoulder pain and disorders have mostly been made among workers who are highly exposed to specific factors at work and have a high prevalence of neck/shoulder disorders (Kilbom et al., 1986; Ohlsson et al., 1994b; Vihma et al., 1982). However, risk factors identified from such studies are highly unusual in most jobs; nevertheless neck/shoulder pain and disorders is very common in the general population. Thus more studies on the aetiology of neck/shoulder pain are needed.

The rapid and continuous changes in modern society regarding employment conditions and company structures will make it difficult in the future to study work environment factors using follow-up study designs. Conditions from baseline may only be relevant during a short period of a person´s working life. The case-control design makes it possible to retrospectively assess conditions prior to disease outbreak, but there may be a risk of recall bias. Company-based or job-title-based data may become less important in the future than individual-based data (Rantanen, 1999), as working conditions also in the same job may change over time and between individuals. Factors involving personal working conditions and work technique might better describe the new working life. It is of importance to recognise risk factors, not those specific to unusual job contexts, but rather factors which could be applied in many different types of jobs. Furthermore, the impact of changes in working conditions on musculoskeletal disorders should be described. There will then be a better chance of preventing the creation of new high-risk jobs.

Methodological considerations

In epidemiological studies, attempts are made to identify risk factors for health problems. With a cohort study design the incidence (the frequency of falling ill) may be studied. When studying musculoskeletal disorders the first episodes of pain may come rather early in life. In order to capture the first as well as recurrent episodes of neck/shoulder pain, the study persons have to be young at baseline and then followed during a long period of time, which is both costly and hard to administrate. The case-control study design is also used in epidemiological research to get information about factors related to the incidence of disorders or diseases. A case-control study has the advantage of being less costly to administrate. The information derived is more limited, but mostly sufficient. To get reliable results, all incident cases in a defined population have to be identified and the controls (referents) must truly mirror the frequency of exposure the factors under study in the same population.

The majority of the conducted studies regarding neck/shoulder pain and disorders have a cross-sectional design. The prevalence of disorders estimated in cross-sectional studies is dependent on both incidence and duration of disorders. The influence of either of these conditions cannot be separated, since cross-sectional studies have no time dimension and no conclusions regarding causal relationship can be derived. However, cross-sectional studies can be useful in epidemiological research in order to generate hypotheses of causal relationships.

Musculoskeletal diseases are often characterized by recurrent episodes of pain, followed by quite healthy periods (Frank et al., 1995). Therefore it is of interest to study not only the very first occasion a person experiences musculoskeletal pain, but also the circumstances that precede other episodes during his/her lifetime.

Studies involving conditions in past time mostly have to rely on self-reports. However, if the exposure information has to be collected retrospectively, a bias may be introduced, due to varying ability to remember in relation to current health

status (Rothman & Greenland, 1998). If the conditions under study are better remembered by subjects suffering from musculoskeletal pain than by healthy subjects, a differential misclassification (i.e. the misclassification of exposure is related to the outcome) might occur, which could result in an overestimation of associations (Rothman & Greenland, 1998). Non-differential misclassifications on the other hand usually result in underestimation of associations, given a dichotomised exposure classification. A study on this topic showed that retrospective assessments of work-related conditions 24 years back in time suffered from differential misclassifications to a certain degree, due to ongoing low back problems, but not neck/shoulder disorders. However, the influence of the misclassifications on the risk estimates was limited (Köster, 1999). This topic should also be studied regarding more recent conditions.

Regarding recall of occupational injuries, a bias was found towards a lower reporting rate when the recall period increased (Zwerling et al., 1995). However, the impact on found associations was small and the author suggests that self-reported survey data, with longer recall periods, may be useful in studying associations between various risk factors and occupational injuries. Regarding recall of symptoms and diseases it was found that patients underreported, compared with doctors' medical records (Cox et al., 1987; Johansson, 1969). Self-reports regarding musculoskeletal pain and disorders are very useful in epidemiological studies, and necessary in most retrospective research. There is a need for validity and reliability studies about self-reports regarding musculoskeletal pain, disorders and diseases.

Previously collected information (i.e. previously performed studies) could be usable when conditions back in time are to be investigated and is often used in epidemiological research (Mannon et al., 1994; Nyström et al., 1990). This type of data is not likely to be biased due to the influence of memory problems, but other sources of inaccuracy may exist. Information has often been gathered for other purposes and may be of less relevance for the present study. Diagnosis given to patients by doctors for sick leave purposes may not include for example musculoskeletal problems, even if they existed, as nobody at that time knew that investigations would be made about such illness later on.

When musculoskeletal disorders and pain are to be studied, it is often appropriate to observe conditions during a long period of time. For financial and practical reasons researchers are mostly compelled to use self-reported data. Self-reports could be derived either from self-administered questionnaires or from interviews. Both these ways of collecting data have certain advantages and disadvantages. Data from interviews may be influenced by the interviewer, while questionnaire data may suffer from misunderstandings and mistakes. From a German study it was concluded that the primary obstacles to overcome in obtaining high-quality interview data retrospectively were not those of faulty recalls, but rather those concerning the quality of interview schedule, training of interviewers and coding of data (Caroll et al., 1986).

Physical exposure data could also be assessed by direct measuring or by observation-based registrations. However, these time-consuming techniques mostly limit the number of possible observations. If different sources of information regarding the same conditions are used, the inter-method reliability can be tested.

If the number of dropouts in a study is high, and if there is big difference between participants and dropouts regarding conditions studied, a bias may occur. Both under-and overestimations of associations may be the result of such a bias. There is need for analyses regarding differences between participants and dropouts, with regard to age and socio-economic status and if possible also concerning exposure conditions, musculoskeletal disorders and sick leave.

Overall aims

The aim of this thesis was to identify risk factors for neck and shoulder pain and disorders. In accordance with the bio-psychosocial perspective used, both physical and psychosocial factors were studied at work as well as during leisure-time. Potential interactive effects of these factors on neck/shoulder pain, and the impact of different lengths of exposure prior to the onset of pain and disorders, were also studied. The specific aims of the five papers were as follows:

Study I: To evaluate the reliability and validity of self-reported retrospective sick leave data.

Study II: To study the long-term relationship between occupational and non-occupational factors in 1969, and neck, shoulder and upper limb disorders during the period 1969-1993. A special aim was to study interactive effects on upper limb disorders from work and leisure-time factors.

Study III: To identify risk factors for neck and shoulder disorders in the general population. Specific aims were to study potential interactive effects of physical and psychosocial conditions on neck/shoulder disorders and also the effects of different lengths of exposure prior to the onset of disorders.

Study IV: To study risk factors for neck and shoulder pain in the general population. Interactive effects of physical and psychosocial factors on neck/ shoulder pain were studied, as well as the impact of long-term high exposure and a recent shift from low to high exposures, respectively.

Study V: To study the impact of a change in production working conditions on musculoskeletal disorders and pain. The impact of long and short exposure time was also studied.

Methods

Social context

Studies covering nearly three decades are included in this thesis. During these years major changes have taken place in Swedish society. Official statistics from Statistics Sweden, such as annual surveys of living conditions ("ULF"), can be used to examine how conditions have changed (Statistics Sweden, 1997). The following descriptions are based on this information and refer to the years 1975-1995.

The educational level among both women and men increased substantially, most among younger women (24-44 years of age) and least among men older than 45 years of age. The proportion of gainfully employed women increased, both among younger and older subjects, while among men a slight decrease in the level of employment could be seen, especially regarding men younger than 45 years of age.

Working conditions changed considerably. Reports of noisy and dirty work decreased, while an increase in reports of heavy lifting could be seen among women. In contrast to reports among women, the amount of heavy lifting decreased among men during the same time period. The number of hours worked was generally higher among men than among women both in 1975 and 1995, although the average working time increased among women. The level of unemployment increased, especially among the younger persons.

The perceived health status improved among the oldest age groups but not in the younger ones. However, in the younger age groups compared to the older groups, a larger fraction of the women and men perceived their health to be good.

Approximately the same results, regarding development of conditions in the workplaces, were found by questionnaire investigations made by trade unions in Sweden among their representatives in the workplaces. Surveys were made both in 1980 and in 1995. Some results also relate to earlier questionnaires from around 1970. The main results were that exposure to dirty work, climatological problems and noisy jobs had decreased, but no such decrease was experienced regarding exposure to repetitive work, awkward postures and heavy lifting. The experience of stress and other psychosocially trying conditions had increased substantially over time (Nilsson, 1996). The decreasing trend regarding physical and chemical work environmental exposures seems to have ceased during recent years and the percentage of the workforce who reported an increase in overtime work, perceived monotony and lack of freedom has increased (Stockholms läns landsting, 1999).

Included studies

The present thesis is based on three separate projects. The REBUS-study, which was part of the "Work after 45" research programme, the MUSIC-Norrtälje study and an evaluation of a changed production process at an automobile plant in Sweden.

The REBUS study (Study I, II and III)

REBUS is an abbreviation of the Swedish name "REhabiliterings Behovs Under-Sökningen". The original REBUS-study was conducted in 1969 with the aim to investigate the need for medical and social services, and to determine to what extent the actual needs were fulfilled (Bygren, 1974). All subjects underwent a medical examination, and medical diagnoses were given whenever appropriate. A musculoskeletal diagnosis requires both symptoms and signs, and also consequences for daily living.

To select the group of participants needed to fulfil 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). All subjects were sent a questionnaire, and on the basis of the answers regarding health status 3,064 subjects were selected to participate in the study. Of these 2,579 actually participated in the REBUS-69 study, underwent a medical examination and were given medical diagnosis whenever appropriate. The way in which participants in the REBUS-69 study were selected has been described in the thesis of Bildt Thorbjörnsson (Bildt Thorbjörnsson, 1999).

In 1993 the youngest subset of the REBUS-study population was contacted with a request to participate in a re-examination (the REBUS-93 study). From the 2,579 participants in the REBUS-69 study, 783 eligible subjects were selected for the REBUS-93 study. All subjects from the 1969 study who were living in Sweden and could be reached, who were without diagnosed musculoskeletal disorders in 1969, and who were below the age of 59 years in 1993, were eligible. Of these 783 subjects, 484 (62%), 252 women and 232 men, finally volunteered to take part in the REBUS-93 study (Bildt Thorbjörnsson et al., 1998; Torgén et al., 1997). Each participant came for a one-day examination, including interviews and self-administered questionnaires concerning physical and psychosocial aspects of work-related and non-work-related conditions.

Prevalence of symptoms of neck pain in 1969 was collected in 1969 by a standardised interview. Self-reported visits to caregivers and sick leave due to musculoskeletal upper limb and neck disorders were collected retrospectively for the time period 1970-1992. Prevalence of neck and upper limb disorders and sick leave in 1993 was collected by a medical interview.

Differences between participants and the dropout group was investigated using registered sick leave from the social insurance offices in Stockholm. Those of the dropouts who were possible to reach were asked some questions over the phone about the reason for not participating, and about occurrence of any neck and upper extremity disorders during the past 12 months.

Study I

The purpose was to study reliability and validity of the data regarding sick leave due to musculoskeletal diseases gathered retrospectively during the REBUS-93 study. Reproducibility of sick leave data was studied by the test-retest method,

and 66 participants filled out questionnaires about sick leave for the time period between the two REBUS studies, at two different times.

In order to study validity, registered sick leave data was obtained from the social insurance offices in Stockholm for the time period 1990-1994. Self-reported sick leave data from the same time period could then be validated against the registered data.

Study II

In this prospective cohort study the long-term relationship between occupational and non-occupational factors in 1969, and neck and upper limb disorders during the period 1969-1993 was studied. Data from the baseline study (REBUS-69) regarding neck pain and different work-related and non-work-related conditions was used, together with reports on visits to caregivers during the period 1970-1993 collected at the follow-up study in 1993 (REBUS-93). Associations between the work and leisure-time circumstances in 1969 and the first reports of upper limb disorders during the period were calculated regarding neck/shoulders and hand/wrist disorders. Reliability of the self-reported data regarding visits to caregivers due to neck and shoulder disorders was investigated regarding the 66 participants who filled out questionnaires on two occasions.

Study III

Using a nested case-control design, associations between working and non-working conditions, prior to the onset of disorders, and neck/shoulder disorders during the period 1970-1993 were studied. Yearly information for the period1970-1993, regarding conditions at and outside work, presumed to be of relevance for neck/shoulder disorders, was collected retrospectively. Cases were identified by self-reported neck/shoulder disorder (either visits to caregivers, sick leave or reported neck/shoulder pain), and an index year (the year of the first reports of disorders) was fixed. All subjects who had not become a case at a certain point in time constituted the group of conceivable controls. Two controls were randomly drawn for each case from this group, matched by age, sex and index year. Associations between previous exposure (1, 5 and 10 years of exposure) and incidence of neck/shoulder disorders were calculated.

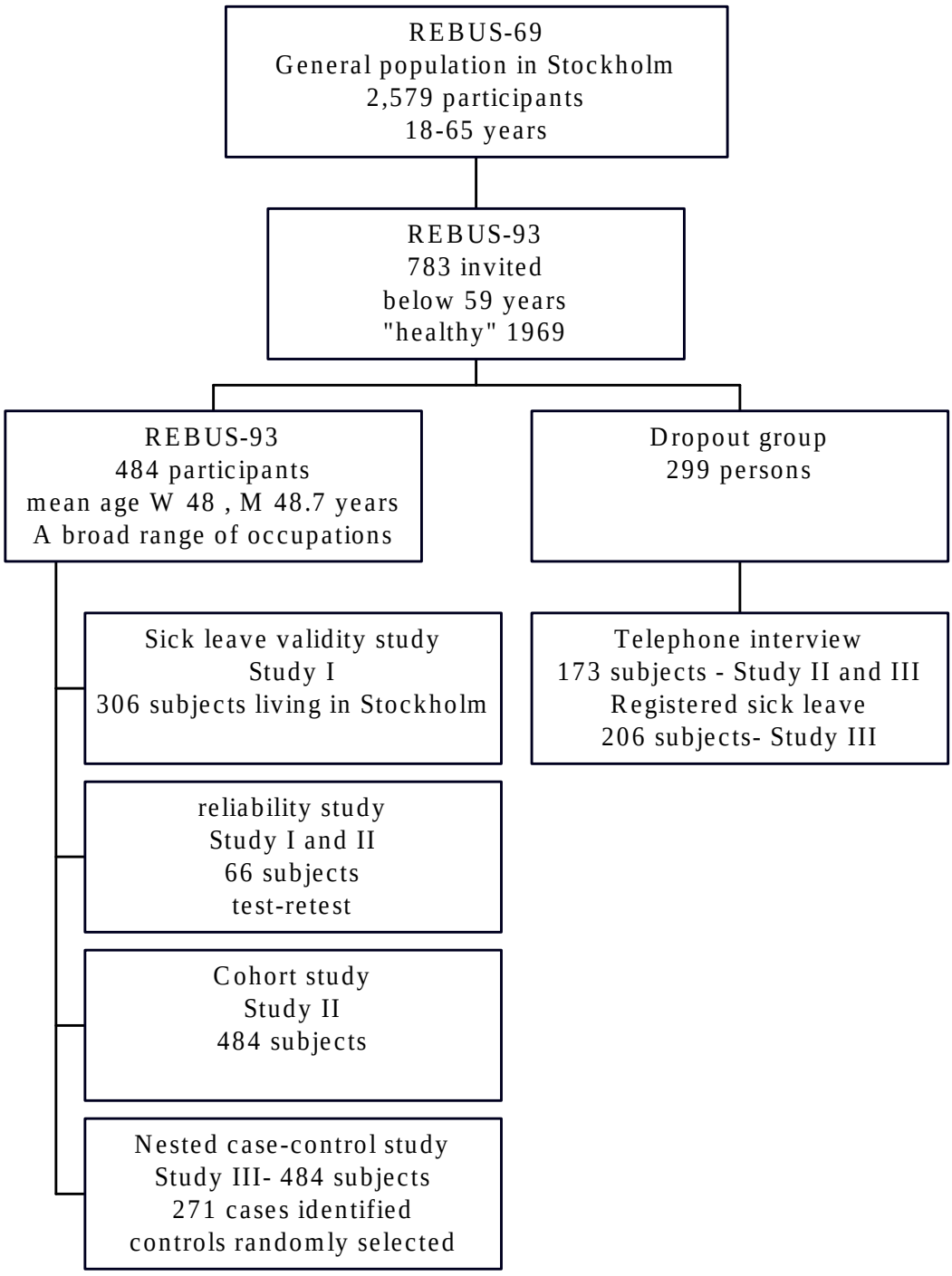

Figure 3. Procedure of selection of participants for REBUS-93 and how the different REBUS studies hang together

The MUSIC Norrtälje study (Study IV)

MUSIC is an acronym for MUSculoskeletal Intervention Centre. The MUSIC-Norrtälje study took place in the municipality and rural district of Norrtälje, situated about 50 km north of Stockholm. The study period was three years, from June 1994 to June 1997 (Vingård et al., 2000).

The study population comprised all men and women, 20-59 years of age, living in the district of Norrtälje and not working or studying outside this area, 17,000 persons in all. The cases were persons from the study base who during the study period sought medical care or treatment for neck/shoulder pain from any of the approximately 60 caregivers, all categories, who were active in the area. We believe that almost all cases were offered to participate in the study, as all caregivers, also non-licensed ones, in the area joined the study. Very few cases refused to participate, and there is no reason to believe that these persons, or the ones that the caregivers may have forgotten to ask in any significant way, differed from those involved in the study.

Controls were selected from the study base as a stratified random sample by means of a population register, taking age and gender into consideration. Neither cases nor controls should have had medical care for low back or neck/shoulder pain within the last six months. Regarding the referents, 70% attended an examination and an additional 10% only filled in questionnaires. All participants were examined by an experienced physiotherapist and the cases were grouped into subjects with and without signs of disorder on the examination day. During the examination day questionnaires were filled in and interviews were carried out.

For this particular study the study base was restricted to persons employed both during the year preceding the examination and five years earlier. A total of 310 out of 392 cases and 1,277 referents out of 1,511 fulfilled the inclusion criteria.

Prospective study about a changed production process at an automobile plant in Sweden (Study V)

In the car-body-sealing department at a large automobile plant, a reorganization of the work from lineout to line production was performed in 1997. The change was made merely for economic and productivity reasons, but ergonomic considerations were also taken into account. It was decided to evaluate the intervention with respect to the ergonomic aspects.

The study group consisted of 57 operators, 20-63 years of age, from the car-body-sealing department, working there both before and after the change. The control group consisted of 45 operators, 21-52 years of age, from another department at the plant where no changes had taken place during the time period in question. Both groups filled in questionnaires at two points in time, before and after the change. The musculoskeletal health of the workers was studied using reports from the occupational health centre and self-reports of musculoskeletal disorders (Kuorinka et al., 1987). The focus was on the impact of the intervention, how it was conducted and how the work environmental factors changed.

Exposure assessment

Rebus study –69 and –93 (Study I-III)

At the REBUS-69 examination, data concerning psychosocial and physical conditions were collected by a structured interview. Seventeen of the questions, all on a dichotomous scale, were of interest for the present study and were grouped into 11 factors.

The following questions regarding physical workload were used: high physical loads at work (either lifting 40 kg for women or 60 kg for men or physical exhaustion at the end of the working day) and severe (whole body) vibrations. Regarding psychosocial conditions, questions about high mental load at work (defined as both hectic work and mental exhaustion at the end of the working day), monotonous work and poor support from closest superior were used. Information on working hours, such as full-time work, night or shift work and overtime work was also gathered.

Regarding non-work-related factors, questions about family support and leisure-time (satisfaction with content and amount) were used. The factor “additional domestic workload”, defined as being both gainfully employed and having responsibility for children and household, was constructed to mirror the total amount of time occupied by duties.

The study group was divided into white-collar and blue-collar workers on the basis of socio-economic status in 1969 (SCB, 1982).

Data about physical conditions, work-related and non-work-related, for the time period between REBUS-69 and REBUS-93, and for current conditions, were gathered by self-administered questionnaires in1993. The participants had been asked to recall their work history. The self-reported work history established a basis for defining annual socio-economic status for the 24 years under study (study III). For each separate occupation held for at least one year, questions were asked about physical workloads presumed to be relevant to the neck/shoulder region. Data from similar leisure-time physical conditions were gathered regarding every fifth year between 1970 and 1993 using a self-administered questionnaire. Data about psychosocial and organisational occupational conditions were asked at a structured interview regarding the same time period.

The questions regarding physical conditions are presented in appendix 1. The conditions in question were defined regarding time per day, week or month spent working under such circumstances. Information about smoking for the time period under study was also gathered. To obtain dichotomised data, cut-off points were chosen on a presumed harmful level of exposure. The same questions and cut-off points were used in study I as in study III.

An RPE scale (Borg, 1970) assessed perceived physical exertion. To be considered as exposed to high perceived physical exertion, the subject should have rated $\geq$12. The cut-off points were based on the exposure distribution in the study group.

Regarding psychosocial conditions, working hours and overtime work, questions were asked about the current situation and about the situation at earlier

time points covering a 24-year period back in time (the time between the two REBUS studies) (Bildt Thorbjörnsson et al., 1999b). Questions and cut-off points are presented in appendix 2.

The MUSIC Norrtälje study (Study IV)

Data about physical conditions, current and five years ago, were collected using a self-administered questionnaire, and data about psychosocial conditions during the preceding five-year period were collected by interview. Using these data the impact of five years of continual exposure, and a recent change towards less favourable conditions, respectively, could be studied

Regarding physical conditions, the questions and cut-off points are presented in appendix 1. Current conditions regarding socio-economic status, irregular working hours and shift work, overtime work, smoking and physical activity during leisure-time were assessed by a self-administered questionnaire.

As in the REBUS study, questionnaire-based information about assessed perceived physical exertion was used. To be considered as exposed to high perceived physical exertion the subject should have rated $\geq$14 (based on distribution among controls).

Regarding psychosocial conditions the participants were asked about their degree of participation in work planning, opportunities to acquire new knowledge and to use existent knowledge, degree of support from colleagues, superiors and also about potential hindrance at work. The participants were asked about current as well as retrospective conditions, and if the situation had been the same or if there had been any changes, for the worse or for the better, within the preceding five-year period (Bradburg et al., 1987).

In the MUSIC study, information about earlier symptoms lasting more than 3 months on any occasion was derived from a self-administered questionnaire. This information was used in the analysis as a potential confounding factor.

Study V

Data about physical and psychosocial conditions were gathered on two occasions, before and after the change. Physical demands were studied using questionnaires, and the psychosocial conditions by questionnaires and group discussions. The physical workload regarding strenuous postures and movements was also assessed by direct measurement using a Physiometer (Aarås & Stranden, 1988) and computer-based observation registration (Fransson-Hall et al., 1995b; Fredriksson et al., 1999) for some members of the study group.

Information regarding the amount of the working day spent on repetitive and precision work, as well as working above shoulder level, below knee level and in twisted positions, was gathered by questionnaire. The measurements were made regarding time spent with bent back, as well as with lifted arms. The observations included information about the percentage of time spent working with bent or rotated neck, bent back and work above shoulder level.

Original scale	Modified scale	
6	0	
7	1	Very, very light
8	2	
9	3	Very light
10	4	
11	5	
12	6	
13	7	Somewhat hard
14	8	
15	9	Hard
16	10	
17	11	Very hard
18	12	
19	13	Very, very hard
20	14	

Figure 4. The original and the modified RPE scale (Borg, 1970) for assessment of perceived physical exertion (Josephson, 1998, with permission).

Percieved physical exertion was assessed using a modified 0-14 RPE scale (Wigaeus Hjelm et al., 1995) How this scale corresponds to the original scale with a range from 6-20, which was used in the REBUS and MUSIC studies, is shown in figure 4.

Information regarding occupational pride, job demands, stimulation from work, opportunities to influence work and experience of positive factors at work was gathered by questionnaire. The social climate at work and the way the intervention was implemented was qualitatively assessed in discussion groups.

Outcome assessments

Visits to medical caregivers due to neck and upper limb pain and/or disorders
Visits to caregivers was used as an outcome measure in all studies except study I. The information about the visits is either from the caregivers (Study IV and V) or from the study subjects (Study II and III).

Sick leave due to musculoskeletal pain and/or disorders
Self-reported sick leave, retrospectively assessed, was used in Study I and III. In study I and V registered sick leave, from the regional insurance offices in Stockholm and from the local occupational health care, respectively, was used.

Self-reports of musculoskeletal pain and/or disorders
Self-reports collected by medical interviews were used in Study II and III. Questionnaire-based information was used in study I and V.

Medical examination
Participants in the MUSIC study (Study IV) were classified into groups of neck/shoulder disorders on the basis of signs revealed during the examination (a/ tension neck, b/ shoulder tendinitis, c/ cervical rhizopathy, d/ subjects free from signs of a/, b/, c/).

Data analysis

Different epidemiological designs and measures
In this thesis the relationship between potential risk factors and neck/shoulder pain was studied by means of the cohort (study II) as well as the case-control design (study III and IV).

In study III a so-called nested case-control design was used. The cases were identified by self-reported neck/shoulder disorders during the period 1970-1993. In study IV the cases were delivered by caregivers.

To evaluate the effect of a certain exposure, a comparison of disease occurrence between exposed and unexposed subjects was made. There are different measures of disease occurrence, namely incidence, cumulative incidence and prevalence. In study II the cumulative incidence ratio, as well as the prevalence ratio, was used to compare exposed subjects with unexposed subjects, regarding episodes of neck/ shoulder disorders. In study III and IV, which were case-control studies, the odds ratio was used to assess the association between exposure and disorders. As these case-control studies were population-based and the controls were randomly selected from the study base, the odds ratios can be interpreted as an estimate of the incidence rate ratios (Miettinen, 1985).

Description of statistical methods and data programs
The analyses were performed using the SAS (SAS, 1989) (study II -V) and CIA (Gardener et al., 1989) (study I and V) (difference in proportions) computer programs.

For analyses of reliability and validity the measures sensitivity, specificity, percentage of agreement and Cohen's kappa were used (Fleiss, 1981). The kappa value can be regarded as a measure of agreement beyond the influence of chance. Results from the analyses were calculated together with 95% confidence intervals (CI) to estimate the precision (study I, II).

To reduce the amount of data and to create more stable variables in study III, indices were constructed on the basis of exploratory factor analyses using the model PROC FACTOR in the SAS statistical software.

Associations between exposure and outcome were calculated, with adjustment for confounding factors according to the method proposed by Mantel-Haenszel (Miettinen, 1976) (study II, III, IV and V) (PROC FREQ). When several factors were considered simultaneously, logistic regression analysis (study IV and V) (PROC LOGISTIC) or Cox regression analysis (study II and III) (PROC PHREG) were used. As measures of association the prevalence ratios (PR),

cumulative incidence ratios (CIR) and odds ratios (OR) were used, depending on the context of the study in question.

Interactions between physical and psychosocial factors at work, or between occupational and leisure-time factors, for the risk of neck/shoulder pain and/or disorders (in study I also hand/arm disorders) were analysed by the method proposed by Rothman (Rothman, 1986). To examine additive interaction between two factors, A and B, subjects reporting both or either of them were contrasted to a reference group reporting neither. The proportion of excess risk was calculated as [RR(A+B)-RR($\bar{A}$+B)-RR (A+ $\bar{B}$)+1]/RR(A+B)], with corresponding 95% CI (Hallqvist et al., 1996; Lundberg et al., 1996). Only interaction terms, where the proportion of excess risk was at least 20 % (the lower confidence limits for the proportion of excess risk at least –0.1) and the RR for the interaction term at least 2.0 with a lower confidence limit of 1.0, are reported.

Exposure time

The impact of exposure time was analysed by using different exposure periods (1, 5 and 10 years) (study III) and by analysing the impact of changes regarding work and/or leisure-time factors (study IV and V). The influence of duration of exposure for different exposures on the incidence of neck/shoulder pain was studied retrospectively in study IV and prospectively with respect to musculoskeletal pain in study V.

In study IV, cases and controls were compared as to their physical and psychosocial conditions in two separate analyses. A) Subjects reporting a presumed harmful condition currently as well as 5 years ago (long-term exposed) were contrasted to subjects reporting no exposure at either of these time points (the unexposed group). B) Subjects reporting current exposure but no exposure at the earlier time point (short-term exposed, i.e. they had increased their exposure during the five-year period) were contrasted to the same unexposed group.

In study V, more than ½ of the women and ¼ of the men had been working at the sealing department for more than 10 years. At the follow-up the participants had worked for about 9 months under the new circumstances. In the study group, the operators could therefore roughly be considered as long-term exposed to the conditions before the intervention and short-term exposed to the new conditions. The impact of the intervention was studied by comparing exposure to physical and psychosocial conditions and prevalence of musculoskeletal disorders, before and after the intervention, both for the study group and the control group.

Gender

Analyses were carried out separately for women and men when the studies included a sufficient number of subjects (study II, III, IV). In study I and V the main analyses were made for women and men together, due to the lower number of subjects.

Reliability and validity

The test-retest reliability of retrospective questionnaire-based information on sick leave and visits to caregivers was evaluated in study I and II. The extent to which a different number of days between filling in the questionnaires, and sick leave periods being recent or long ago, influenced the reliability was also analysed.

The validity of self-reported retrospective questionnaire-based information on sick leave was analysed using registered sick leave data as a criterion (study I). The influence of ongoing self-reported disorders (Kuorinka et al., 1987) and different current exposure on the validity was analysed. Registered sick leave data was also used to validate the case status derived from self-reports in study III.

Dropouts

Data from the REBUS-69 study regarding the number of subjects exposed to different conditions and regarding the number of subjects with neck symptoms in 1969 was analysed for both the participants in the REBUS-93 study and for those who chose not to attend the follow-up.

In order to compare the study group and the non-participants in the REBUS-93 study (38% of the eligible 783 subjects), a telephone interview was conducted with 173 non-participants who could be reached, in order to ask about neck and shoulder disorders during the last 12 months, using the Nordic questionnaire (Kuorinka et al., 1987). In addition, data on registered sick leave for the last 4 years for those of the 783 eligible subjects from the REBUS-69 study who were living in the county of Stockholm in 1993 (=512) were obtained from the local insurance offices. These data were used to investigate whether there were any differences between the study group and the non-participants regarding prevalence of disorders and registered sick leave.

In study I possible differences between the study group and the lost-to-follow-up group regarding socio-economic status, self-estimated amount of sick leave and current disorders were analysed.

Results

In this thesis results regarding neck/shoulder pain and disorders are presented for persons 20-59 years of age. In study I, II and III the subjects were 42-58 years of age, but in study IV and V the studied persons are more spread regarding age.

Study I

The concordance between test and retest regarding self-reported sick leave data due to musculoskeletal illness was high (Table 1). Kappa values greater than 0.75 are considered as excellent, values between 0.40 and 0.75 are fair to good, and values below 0.40 represent poor agreement beyond chance alone (Fleiss, 1981). No statistically significant differences regarding different time lag between answering the two questionnaires, and regarding reliability of data from the first part of the time period compared to that of the latter, were found.

The validity part of the study showed a high percentage of agreement with registered data (89-97%) and moderately high kappa values (0.50-0.81) (Table 2). In the analysis for the body regions neck/shoulder and low back separately, almost all the values improved when compared with the A level of concordance, except for the kappa value of the men. Among men, a slight difference in validity was found between subjects exposed and not exposed to time pressure. No other exposure or effect–dependent (current musculoskeletal disorders) sources of misclassification were found. No differences between the lost-to-follow-up group and the study group were found regarding socio-economic status, self-estimated amount of sick leave or current musculoskeletal disorders, but the men in that group were slightly older than those in the study group (mean age 48.1-46.7 years).

Table 1. Test-retest reliability of self-reported sick leave >7 days, concerning sick leave for neck, shoulder, hand/wrist or low back illness during the period 1970-1992 among 66 persons (32 women and 34 men).

	Questionnaire * 1	Questionnaire* 2	Agreement between questionnaire 1 and questionnaire 2	Kappa value
Women	34 %	41 %	88 %	0.73
Men	29 %	26 %	97 %	0.93

*Percent of subjects reporting sick leave due to musculoskeletal diseases

Table 2. Validity of retrospective self-reported sick-leave data related to musculoskeletal diseases in the back and limbs. Prevalence of self-reported and registered sick leave is given for 304 persons (160 women, W, and 144 men, M). The data has been analysed in relation to different levels of concordance: A-Concordance concerning both the number of sick-leave days and diagnosis (musculoskeletal illness), B- concordance concerning diagnosis only, C- concordance concerning sick leave or not (any diagnosis). In the separate analysis of neck/shoulder (D) and (low) back (E), concordance concerning diagnosis, but not number of days of sick leave, was evaluated; 95% confidence intervals (CI) are also given for the kappa values.

	Register data (%)		Self-reported data (%)		Agreement (%)		Sensitivity		Specificity		Kappa with 95%CI	
	W	M	W	M	W	M	W	M	W	M	W	M
A	14	9	15	13	89	93	0.64	0.85	0.93	0.94	0.54 W 0.36-0.73 M 0.45-0.85	0.65
B	16	10	16	13	92	94	0.76	0.86	0.95	0.95	0.70 W 0.54-0.85 M 0.51-0.88	0.69
C	18	12	16	13	94	96	0.79	0.88	0.98	0.97	0.80 W 0.68-0.93 M 0.66-0.96	0.81
D	9	3	9	6	93	97	0.64	1.0	0.96	0.97	0.58 W 0.36-0.81 M 0.34-0.97	0.50
E	7	4	9	8	94	95	0.73	0.83	0.96	0.96	0.61 W 0.38-0.84 M 0.28-0.85	0.56

Study II

The percentage of gainfully employed subjects exposed to the analysed risk factors differed between 1969 and 1993, especially among women (table 3). More women than men reported visit to caregivers due to neck and upper limb (shoulders and hand/wrist) disorders for the whole time period under study.

The kappa values for the test-retest reliability regarding self-reported data on disorders leading to visits to caregivers among those 66 participants who filled in the questionnaire at two different points in time, varied between 0.60 and 0.86.

Association between exposure and outcome

No associations were found between any of the potential risk factors and the prevalence of neck symptoms in 1969 among women. No analysis could be done for men, as the number of cases was too small.

Table 3. Percentage of the study group exposed to different potential risk factors in 1969 and 1993. Results are given as a percentage of the people at work in 1969 and in 1993 concerning work-related risk factors, and as a percentage of the whole group concerning non-work-related risk factors.

	Women		Men	
Potential risk factor	1969 n=147	1993 n=225	1969 n=188	1993 n=211
Blue-collar work	37	29	47	33
High physical load at work	28	38	39	31
Vibrations	2	6	20	18
High mental load at work	15	36	18	25
Monotonous work	19	7	13	7
Low social support at work	20	12	16	15
Full-time work	83	75	98	97
Night or shift work	11	20	8	18
Overtime work	10	31	44	43
Additional domestic work	36		10	
Low family support*	21		22	
Unsatisfactory leisure-time*	39		31	

*women, n=252; men, n=232

Few single factors were associated with *neck disorders* during the period 1970-1993, except monotonous work among women (table 4) and night or shift work among men (not in table). For combinations of work-related and non-work-related factors, however, strong associations were found. The highest PR (10.9) was for unsatisfactory leisure-time combined with shift work among men, while the number of interactions was higher for women than for men regarding neck disorders (not in table).

The associations between overtime work in 1969 among women (table 5) and blue-collar work among men (table 6) and prevalence of *shoulder disorders* in 1993 remained significant in the multivariate analysis. Some interactions were found both among women and men, and the highest PR (4.0) was for unsatisfactory leisure-time combined with blue-collar work among men (not in table).

Among both women and men few single factors were found to be associated with *hand/wrist disorders*, but several strong interactions were found, and the combination of additional domestic workload and low family support was associated with prevalence of hand and wrist disorders in both sexes (not in table). Among women interactive effects were also found between high physical loads at work and additional domestic workload regarding prevalence of hand/wrist disorders (not in table).

Associations between neck symptoms in 1969 and subsequent disorders

In women, symptoms in the neck in 1969 were related to neck disorders in 1993 (PR 2.4 95% CI 1.4-4.1) No interactions regarding neck disorders in 1993 were found between factors related to work and leisure-time and neck symptoms in 1969.

Table 4. Associations between different exposures and reported medical treatment or consultation for disorders of the *neck* among 252 women relative to potential risk factors in 1969.

		High mental load at work	Monoto-nous work	Overtime work	Dissatis-factory leisure-time	High mental load at work + dissatisfactory leisure-time
CIR (95%CI)	Age adjust. analysis	1.3 (0.7-2.5)	1.7 (1.0-2.9)	1.8 (0.9-3.4)	1.9 (1.3-2.8)	
1970-1992 (n=228)	Multivariate analysis	*0.6 (0.1-4.4)*	1.7 (0.9-3.5)	*1.4 (0.6-3.6)*	*1.4 (0.7-2.7)*	*2.0 (0.7-5.6)*
PR (95%CI)	Age adjust. analysis	1.8 (1.0-3.5)	*0.8 (0.4-1.7)*	2.3 (1.0-5.0)	1.2 (0.8-2.0)	
1993 (n=252)	Multivariate analysis	1.1 (0.2-4.9)		*1.7 (0.6-4.7)*	1.0 (0.5-2.3)	2.8 (1.1-7.3)

CIR= cumulative incidence ratios 1970-92, and PR= prevalence ratios 1993 relative to potential risk factors in 1969. Some values (in italics), which are not used for further analyses or without explanatory value in the final multivariate analyses, are entered for information.

Table 5. Associations between different exposures and reported medical treatment or consultation for disorders of the *shoulders* among 252 women relative to potential risk factors in 1969.

		High mental load at work	Overtime work	Dissatisfactory leisure-time	High mental load at work + dissatisfactory leisure-time
CIR (95%CI) 1970-1992	Age adjust. analysis	*1.1 (0.6-2.3)*	*1.1 (0.4-2.9)*	1.5 (1.0-2.2)	
PR (95%CI)	Age adjust. analysis	1.8 (1.0-3.5)	3.1 (1.6-6.2)	*1.0 (0.7-1.7)*	
1993	Multivariate analysis	*1.2 (0.3-4..4)*	2.7 (1.1-6.9)	*0.7 (0.3-1.7)*	*1.7 (0.6-4.8)*

Footnote as for table 4

Table 6. Associations between different exposures and reported medical treatment or consultation for disorders of the *shoulders* among 232 men relative to potential risk factors in 1969.

		blue-collar work	high mental load at work	night or shift work	additional domestic workload	high mental load at work +add. domestic workload
CIR (95%CI)	Age adjust. analysis	2.9 (1.4-6.1)	1.9 (0.8-4.3)	3.1 (1.4-7.0)	2.4 (0.9-6.5)	
1970-1992	Multivariate analysis	1.7 (0.8-3.6)	1.5 (0.6-4.1)	*1.1 (0.3-3.6)*	1.9 (0.4-8.0)	2.8 (0.8-9.3)
PR (95%CI)	Age adjust. analysis	2.9 (1.4-6.1)	1.9 (0.8-4.3)	2.5 (1.1-5.9)	2.4 (0.9-6.5)	
1993	Multivariate analysis	3.6(1.1-11.3)	*1.7 (0.6-4.9)*	*1.9 (0.5-7.2)*	*1.5 (0.4-5.6)*	

Footnote as for table 4

Subjects who dropped out
Fewer women in the study group (10%) than in the dropout group (17%) reported monotonous work in 1969. More men in the study group (21%) than in the dropout group (13%) reported few or unsatisfactory social contacts. Neck symptoms at the examination in 1969 were almost equally common in the study group and in the dropout group. No significant differences for other potential risk factors were found.

According to the telephone interview, no significant differences between the study group and the dropout group were found regarding upper limb musculoskeletal disorders during the last 12 months. Nor were any differences noted between groups regarding registered sick leave in the last 4 years, except that there were a few more women with very long sick-leave periods among the dropouts.

Study III

Data about the participants work history during the period 1970-1993 was collected and it was observed that most women worked in administrative work, health care or in commercial jobs, both at the beginning of and throughout the whole time period. Men, on the other hand, worked primarily in the manufacturing sector, with some technical work, transportation, or administrative or commercial jobs, at the beginning of the period. A change towards less work in manufacturing and more administrative jobs was seen among men over the time period under study.

Regarding exposure to different factors, presumed to contribute to development of neck/shoulder disorders, gender differences were seen. More men than women reported work with vibrating hand tools, high physical workload and poor social relations at work. Among women high time pressure and monotonous work was more common than among men.

Association between exposure and outcome
Interactive effects on neck/shoulder disorders both from different work-related conditions and in factors from working life and leisure-time were seen among both men and women. In table 7 some of the main results from the analysis of associations between exposure and outcome are presented for women and men, respectively. Five years was the main exposure period analysed. There was no consistent evidence that expanding exposures from 5 to 10 years produced higher relative risk estimates. Blue-collar work only marginally changed the estimated ORs when introduced into the models, and was therefore not included in the multivariate analysis.

Table 7. Conditional logistic regression analysis of associations between different work and leisure-time factors and neck/shoulder disorders for different exposure periods, 1970-1993. Odds ratios (OR) and 95 % confidence intervals (CI).

Women (n= 252)	1 year of exposure	5 years of exposure	10 years of exposure
Potential risk from working life and leisure-time	OR 95% CI	OR 95% CI	OR 95% CI
High perceived workload + Low influence over work conditions	1.1 (0.6-2.2)	2.5 (1.2-5.1)	1.8 (0.7-4.5)
High perceived workload	2.7 (1.3-5.7)	1.2 (0.6-2.2)	0.8 (0.4-1.6)
Low influence over work conditions	0.8 (0.4-1.3)	0.9 (0.5-1.6)	0.8 (0.4-1.5)
Few opportunities for development + Monotonous work	2.0 (0.8-5.0)	2.5 (0.8-7.7)	2.2 (0.6-8.0)
Few opportunities for development	1.1 (0.6-2.2)	1.1 (0.5-2.4)	0.9 (0.4-2.0)
Monotonous work	0.9 (0.5-1.6)	1.0 (0.6-1.6)	0.9 (0.6-1.5)
Frequent work with the hands during leisure-time + High physical workload index	1.3 (0.6-2.7)	2.3 (1.0-5.1)	2.9 (1.2-7.0)
Frequent work with the hands during leisure-time	1.3 (0.8-2.1)	1.2 (0.8-1.9)	1.1 (0.7-1.9)
High physical workload index	0.9 (0.4-1.8)	0.8 (0.3-1.7)	0.7 (0.2-1.8)
Frequent hand movements at work	1.4 (1.0-2.1)	1.5 (1.0-2.3)	1.6 (1.0-2.4)
Smoking (minimum 10 years)	1.5 (1.0-2.3)	1.4 (1.0-2.2)	1.9 (1.2-2.9)

Men (n= 232)	1 year of exposure	5 years of exposure	10 years of exposure
Potential risk from working life and leisure-time	OR 95% CI	OR 95% CI	OR 95% CI
Frequent hand movements at work + Work with vibrating tools	2.2 (0.9-5.2)	1.8 (0.8-4.3)	1.9 (0.8-4.6)
Frequent hand movements at work	1.3 (0.7-2.2)	1.2 (0.7-2.1)	1.2 (0.7-2.2)
Work with vibrating tools	0.4 (0.1-1.0)	0.7 (0.3-1.6)	1.1 (0.5-2.5)
High physical workload index + Poor social relation index	3.4 (1.4-8.4)	2.5 (1.0-6.3)	1.2 (0.4-3.4)
High physical workload index	1.1 (0.6-2.3)	1.4 (0.7-2.8)	1.2 (0.6-2.5)
Poor social relation index	0.6 (0.3-1.1)	0.7 (0.4-1.4)	0.7 (0.4-1.5)
Frequent work with the hands during leisure-time	2.0 (1.0-3.9)	2.4 (1.2-4.8)	2.1 (1.0-4.5)

Study IV

Among women, the percentage of cases and controls having a current blue-collar job, was almost the same, whilst among men more cases than controls were blue-collar workers. Regarding long-term exposure, men reported more use of vibrating hand tools, and more lifting and carrying than women did. Women more often than men considered that they had to do most of the housework.

Association between exposure and outcome

Long-term exposure. The age-adjusted analyses resulted in a number of long-term conditions that were associated with seeking care for neck/shoulder pain, some of which differed between men and women (not in table). Adjustment for smoking, physical activity during leisure-time and overtime work only changed the RRs marginally and was therefore not used in the further analyses. Adjustment for previous neck/shoulder disorders, socio-economic status and irregular working hours, however, resulted in changes for some RRs and these factors were therefore included in the multivariate analysis (Table 8 and 9). When these adjustments were made, long-term perceived high workload, frequent work with the hands or fingers and hindrance at work remained associated with neck/shoulder pain among women. Among men only long-term work with hand-held vibrating tools showed a tendency to be associated with neck/shoulder pain in the multivariate analysis. The multivariate analyses presented in table 8 and 9 were performed for each exposure separately, with the adjustments presented. When a model was constructed, including those exposures showing significant influence among women, the point estimates were only marginally affected, with the exception of a lowered risk among those women perceiving long-term high workload.

Interactive effects on seeking care due to neck/shoulder pain were observed among women, between hindrance at work and both perceived high workload and frequently working while doing bending and twisting movements. Interactive effects were also observed between having a job that required frequent hand or finger movements and doing the main part of the daily domestic work. Among men no interactive effects were found regarding exposures studied.

Short-term exposure: For all items studied, except for work with visual-display terminals (VDT), fewer subjects were short-term exposed than long-term exposed within the 5-year period under study (not in table). In all socio-economic groups there were subjects, both women and men, who had experienced changes towards less favourable conditions. Male blue-collar workers more frequently reported adverse changes regarding more than one exposure than white-collar workers did. Women who had experienced more than one change towards less favourable conditions were more evenly distributed regarding socio-economic groups.

Among both women and men, recent short-term exposure resulted in substantially increased RRs compared to those derived from analysis of long-term exposure (table 8 and 9).

Different multivariate models including the short-term factors with a lower 95% CI of at least 1.0 could be constructed among women. The main finding was that an increase of frequent hand/finger movements was no longer associated with neck/shoulder pain, while for the other factors all RRs were raised above values displayed in table 9, but the confidence limits became wide. Due to the small number of subjects exposed, no interactive effects regarding short-term exposure, neither among women nor men, could be studied.

Table 8. Relative risks for seeking care because of neck/shoulder pain with corresponding 95% confidence intervals among 210 female cases and 698 female controls from the study population in Norrtälje, Sweden during the period1993-1997. Long-term exposed* and short term exposed** compared to long-term unexposed and percentage of referents reporting different exposures.

Work-related factors	%	RR§*	CI	RR§**	CI
High perceived workload >=14 on the RPE scale ¶	19	1.6	1.0-2.6	2.6	1.4-4.9
VDT-work>50% of the working day	5	1.0	0.4-2.2	2.1	1.0-4.1
Work with hand-held vibrating tools>5% of the day	5	0.8	0.3-1.9	† †	
Work with hands above shoulder level>1/2 hour/day#	16	1.3	0.8-2.0	3.4	1.3-8.8
Work requiring frequent bending and twisting#	39	1.3	0.9-1.8	1.4	0.5-3.4
Frequent hand/finger movements at work#	37	1.8	1.2-2.6	2.6	1.0-6.0
Lifting and carrying 1-15 kg#	46	1.2	0.8-1.8	2.6	1.1-5.8
Lifting and carrying more than 15 kg#	18	1.0	0.6-1.5	1.0	0.3-2.5
No participation in work planning	30	0.9	0.6-1.4	0.6	0.2-1.5
No opportunities to acquire or use new knowledge	6	0.7	0.3-1.6	3.7	1.1-12.8
No support from colleagues or superiors	6	1.2	0.6-2.4	† †	
Hindrance at work †	25	1.5	1.0-2.2	† †	
75% of the spare time used for housework	14	1.1	0.6-1.7	1.6	0.8-3.2

Table 9. Same as table 8 for men (100 cases and 579 controls)

Work-related factors	%	RR§*	CI	RR§**	CI
High perceived workload >=14 on the RPE scale ¶	25	0.7	0.4-1.3	1.1	0.4-2.7
VDT-work>50% of the working day	4	0.7	0.1-2.4	† †	
Work with hand-held vibrating tools>5% of the day	43	1.6	0.9-2.7	1.9	0.6-5.5
Work with hands above shoulder level>1/2 hour/day#	20	0.9	0.5-1.5	† †	
Work requiring frequent bending and twisting#	41	1.2	0.7-1.9	2.1	0.6-6.9
Frequent hand/finger movements at work#	37	1.2	0.7-1.9	1.4	0.4-3.7
Lifting and carrying 1-15 kg#	61	0.9	0.5-1.6	† †	
Lifting and carrying more than 15 kg#	41	1.4	0.8-2.4	† †	
No participation in work planning	25	1.2	0.7-2.2	2.9	0.8-9.4
No opportunities to acquire or use new knowledge	5	1.3	0.4-3.4	† †	
No support from colleagues or superiors	6	0.4	0.1-1.5	† †	
Hindrance at work †	22	1.2	0.7-2.1	† †	
75% of the spare time used for housework	5	† †		† †	

* Defined as current exposure and exposure 5 years ago for physical factors, and exposure during a 5-year period for psychosocial factors.

** Defined as current exposure but no exposure to the physical factors 5 years ago, and as an increase in level of exposure to the psychosocial factors within the last 5-year period.

§ Adjusted for age (5-year age groups), earlier neck/shoulder disorders, irregular working hours and socio-economic status;

¶ (Borg, 1970).

Reports of exposure more than one day per week.

† Hindrance regarding tasks/goals, resources of material, personal resources, resources regarding knowledge and environmental conditions, regarding customers, physical conditions and society were assessed on a scale 1-4 for each item separately. The degrees of hindrance at work were summed up and if the sum revealed a high degree of hindrance for at least one of the included items or more than irritating hindrance for at least more than half of the included items, the subject was considered exposed.

† † No analysis done, as less than 5 cases or controls were exposed to the factor.

Additional analyses

If the analyses were restricted only to those cases that received a confirmed diagnosis in the clinical examination, only minor changes regarding the relative

risk estimates were found. The confidence intervals became wider and a trend was seen towards raised RRs, especially regarding short time exposure.

The reliability of the results was tested by 1) re-adding the 30 subjects who had been excluded, as they had changed jobs due to neck/shoulder disorders, 2) adding 224 subjects who did not attend the interview but filled in questionnaires (only regarding physical conditions), 3) making an analysis including only those 888 subjects who had never before experienced neck/shoulder pain for more than 7 consecutive days. In all these analyses (made separately) the RRs changed only marginally compared with the results displayed in Table 8 and 9. The differences between long-term and short-term exposure, regarding seeking care for neck/shoulder pain, were confirmed.

Study V

Physical conditions

Before the change the work at the department of the study group included more work above shoulder level and repetitive work with the hands than that of the control group.

After the change the perceived exertion for the study group increased from 2.9 to 5.8. Regarding other items, no statistically significant changes were found with regard to the questionnaire-based information. No changes in the physical work-load during the same time period were identified for the control group.

The measurements and the data-based observation registrations among a subgroup of the study group indicated a decrease in the time spent in strenuous positions. A statistically significant decrease in the time spent with the head and trunk in a forward-bent position, and in doing repetitive work with the hands, was derived from the observation data.

Psychosocial conditions

Before the change, 35% of the operators in the study group and 66% in the control group considered that their work involved little stimulation. 52% in the study group and 29% in the reference group reported that their job was demanding.

After the change a marked decrease was seen for the study group, regarding their opportunity to influence their work, and the degree of stimulation they considered the work to have (Figure 4). As far as the control group was concerned, their sense of craftsmanship increased, but their opportunities to influence their work decreased during the same time period.

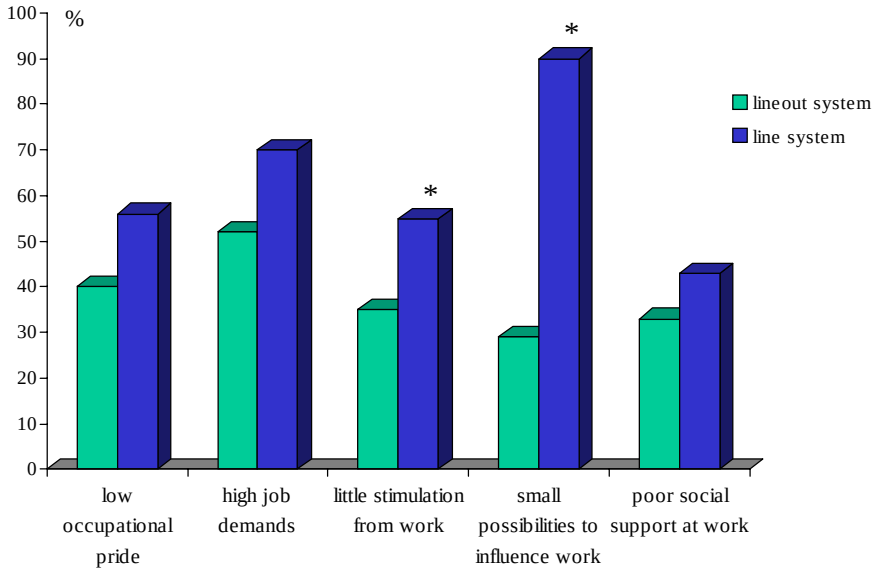

Figure 4. Proportion of operators from the study group, 33 women and 24 men, reporting adverse psychosocial working conditions before and after a change from a lineout system to a line system. * Statistically significant change, $p<0.05$.

Physical well-being

The rate of sick leave increased for both groups and with approximately the same rate as for corresponding groups in the Swedish society during the time period in question. The study group visited the health care center for musculoskeletal diseases significantly more than the control group both before and after the change.

The questionnaire-based information about musculoskeletal disorders during the last 7 days showed a considerable increase in disorders among the study group regarding neck, shoulders and hand/wrist (not in table). No such increase was seen among the control group.

After the intervention the prevalence of neck, shoulders and low back disorders increased for the study group compared to the control group, but statistically significant results were only derived regarding low back disorders (OR 7.2 95%CI 1.5-35.1). High perceived workload and a reduced occupational pride were items which were associated with disorders after the intervention (Table 10).

The implementation of the change

It was planned that the implementation of the new work organisation should take place successively and that the operators should be involved in the process. However, this was not how it was carried out, and production always got priority. This was a source of disappointment among operators.

Table 10. Associations between different physical and psychosocial working conditions and musculoskeletal disorders during the last 7 days in different anatomical regions among 78 operators working at an automobile assembly plant. Odds ratios (OR) and 95% confidence intervals (CI), adjusted for gender.

	Anatomical regions					
	Neck		Shoulders		Low back	
	OR	95% CI	OR	95% CI	OR	95% CI
High perceived physical exertion	5.6	1.8-21.2	4.9	1.4-20.4	6.4	2.0-24.4
Low occupational pride	1.8	0.6-6.0	4.6	1.3-18.6	3.6	1.1-12.8

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Discussion

Risk indicators for neck/shoulder pain and disorders

The results in this thesis support the hypothesis regarding causal relationship between repetitive work with the hands and incidence of neck/shoulder pain and disorders. A new finding is that also repetitive work during leisure-time was observed to be a risk indicator. Regarding forceful exertion at work no clear relationship was found. Some results only point towards adverse effects when the exposure was recently experienced. However, exposure to both high physical load at work, and physical and psychosocial factors from leisure-time was associated with neck/shoulder disorders. Regarding work with vibrating tools, evidence for a relationship was found only when this exposure was concomitant with exposure to repetitive hand movements at work or in leisure-time. This is in concordance with findings regarding combined effects of segmental vibration and static load or forceful shoulder muscle exertion work on shoulder tendinitis (Burdorf et al., 1991; Stenlund et al., 1993; Viikari-Juntura et al., 1994).

Associations between psychosocial conditions and neck/shoulder disorders, as well as between perceived high workload and neck/shoulder disorders were observed, as earlier identified in cross-sectional studies and a few case-control studies. Regarding associations between time pressure and neck/shoulder disorders (Bongers et al., 1993; Ekberg et al., 1994), the results in this thesis do not support earlier findings.

Interactive effects

One of the main findings in this thesis was that combinations of various factors, physical and psychosocial, work-related and non-work-related, more than separate factors were associated with the incidence of neck/shoulder pain and disorders. The interactive effects found in this thesis regarding physical and psychosocial work-related conditions were in concordance with findings in earlier cross-sectional studies (Brulin et al., 1998; Linton, 1990.; Punnett, 1998). In another study on the MUSIC material it was suggested that the concomitant effect of single moderate harmful conditions might explain the high incidence of neck/shoulder pain in the general population (Ewa Wigaeus Tornqvist et al, in manuscript).

A bio-psychosocial perspective

In this thesis factors from work and leisure-time, both physical and psychosocial, have been studied. The aim was to include as much as possible of factors, which could be presumed to be of relevance for neck/shoulder disorders. Hobbies and other activities in leisure-time have mostly been looked upon as positive factors,

delaying aging and protecting individuals against various diseases, including musculoskeletal problems (Blair et al., 1992; Helmrich et al., 1994; Kriska et al., 1988; Lemaitre et al., 1999). But leisure-time activities may also include monotonous and repetitive movements, and in this thesis they seemed to be almost as deleterious as corresponding work-related conditions. Especially the concomitant existence of various exposures at work and in leisure-time was identified as a risk indicator for neck/shoulder pain and disorders. No preventive effect from physical activity during leisure-time could be found, and this is in concordance with other studies (Barnekow-Bergkvist et al., 1998a; Ekberg et al., 1994; Linton, 1990.).

Interactive effects between housework and physical work-related conditions have been observed regarding psychosomatic strain (Hall, 1989; Hall, 1992), but the author concludes that "we lack sufficient evidence from which to draw conclusions about the relationship between structural factors at work (such as occupational strain) and the health of women workers." The same author also suggests that " for many women working life may not necessarily represent an experience of autonomy, freedom, or an opportunity for increased participation in the economic and political life of society". Also, for women in some jobs the housework is just a continuation of the working day's activities, while men often do different things at work and at home. For women reporting that they had to do most of the daily household duties, no increased risk of neck/shoulder pain was found if they were not also had a job which required frequent hand or finger movements (study IV). In study II no increased risk of neck disorders were found for women with additional domestic work load if they were not also exposed to high physical load at work.

The influence of factors concerning working time, such as overtime work and irregular working hours, highlights the importance of including as many different aspects of life as possible in the analysis of neck/shoulder pain. Associations between the amount of time worked and neck/shoulder symptoms have earlier been found in cross-sectional studies (Kamwendo et al., 1991; Waersted et al., 1991).

Aspects such as genetic factors, personal vulnerability and ethnicity, presumed to be of importance for musculoskeletal health (Sivik et al., 1995), have not been dealt with in this thesis. The reason why ethnicity was not studied was that when the REBUS cohort was built up, only a minor group of the Stockholm citizens were not native Swedes. In the district of Norrtälje it is still the case in the 90s that only a small section of the population were born in other countries. Therefore the number of subjects was too small to study the impact of ethnicity. The impact of earlier neck/shoulder disorders, both assessed by interview and collected retrospectively by self-reports, may act as an indirect measure of personal vulnerability. The result indicates a considerable impact from earlier episodes of neck/shoulder disorders on new episodes of neck/shoulder pain, as found in a few other studies (Ålund et al., 1992; Ekenbäck et al., 1991).

In this thesis smoking was only found to be associated with neck/shoulder disorders among women, and only in the REBUS study (Study III). Other

researchers have also found a slightly increased risk among male smokers (Barnekow-Bergkvist et al., 1998a; Ekberg et al., 1994; Linton, 1990.). The impact of smoking on neck/shoulder pain and disorders needs to be further studied.

Gender differences

In almost all studies, including those incorporated in this thesis, the prevalence of neck/shoulder disorders and pain has been found to be higher among women than among men (Arbetarskyddsstyrelsen & Statistiska centralbyrån., 1995/96; Bernard, 1997; de Zwart, 1997; Nordander et al., 1999). The explanation for this dissimilarity has differed from biological differences (Byström et al., 1995) and impact from too much housework (Hall, 1992), to unequal conditions at work due to different body dimensions (Courville et al., 1991; Karlqvist, 1997; Hedberg et al., 1981) or to gender-specific distributions of work tasks (Silverstein et al., 1986; Nordander et al., 1999).

In this thesis the exposure patterns found to be associated with the incidence of neck/shoulder pain and/or disorders differed between genders. More often interactive effects were seen among women than among men. Among women both physical and psychosocial factors from work interacted with non-work-related factors. Among men on the other hand, mostly physical factors, from both work and leisure-time, were found to interact.

The psychosocial factors used in the REBUS and MUSIC studies were not identical, but a consistent result was that having few opportunities for development was associated with neck/shoulder disorders among women but not among men. Do women and men put different meanings in the words when describing their psychosocial working conditions? No such tendencies were seen in a study about questionnaire-based information on the demand-control model (Ahlberg-Hultén, 1999; Karasek et al., 1990; Theorell, 1996). No explanation for the gender difference regarding associations between development opportunities and neck/shoulder disorders could be found in the included studies.

Women and men seldom do exactly the same job, although they might work at the same workplace (Fransson-Hall et al., 1995a; Messing et al., 1994; Nordander et al., 1999). The fact that women's jobs more often than men's include repetitive work tasks (Westberg, 1998) even at the same workplace (Silverstein et al., 1986; Nordander et al., 1999) may explain the higher prevalence of neck/shoulder disorders among women, but not the difference in risk ratios. However, it has been suggested that women are more vulnerable than men to adverse effects at work such as job routinization (Roxburgh, 1996). This issue needs to be further studied.

Exposure time and effects of changes

The impact of different exposure periods was investigated in study III, IV and V. It was found that an increase in exposure time mostly did not result in an increase in the risk ratios of neck/shoulder pain and disorders, rather the contrary (study III

and IV). In study IV and V the impact of recent changes was studied. The main findings were that worsened psychosocial conditions might lead to neck/shoulder pain and musculoskeletal disorders. Regarding deteriorated physical conditions, the results are not concordant. In study IV a recent increase in time spent with work above shoulder level, lifting and carrying loads and doing repetitive work with the hands also increased the relative risks of neck/shoulder pain. However, in study V the prevalence of musculoskeletal disorders increased, in spite of a recent moderate decrease in physical exposure. Many of the operators from study V had been working at the sealing department for a long time. Both before and after the change the work included more work above shoulder level than in the general population (Wiktorin et al., 1999). A multi-factor model (Rothman, 1986), stating that different exposures together, but not single exposures, may cause illness, has been found relevant regarding neck/shoulder pain (Brulin et al., 1998; Linton, 1990.; Punnett, 1998), hand/wrist tendinitis (Putz-Anderson et al., 1997) and disorders of the low back (Bildt Thorbjörnsson et al., 1998; Bildt Thorbjörnsson et al., 1999a). A possible explanation for the results in study V is that when the operators, who had been working under strenuous physical conditions for a long time, learnt that their hopes for better conditions and more participation in the change process were dashed, and/or experienced deteriorated psychosocial conditions, musculoskeletal disorders increased.

Possible explanations for the observed differences regarding incidence of pain and disorders between long and short time exposures might be that individuals will adopt a better work technique, or start to use lifting facilities or other ergonomic equipment after some time. The associations for long-term exposure may also be lowered by the so-called “healthy workers effect” (Punnett, 1996), i.e. that only those who are very healthy stay in a demanding job. Regarding repetitive work among women, coping strategies and adaptation of soft tissues seems not to be enough to prevent neck/shoulder pain leading to visits to caregivers after up to 10 years of exposure.

Changes in working conditions in modern Swedish working life have been investigated in the MOA-study (Modern work and living conditions for women and men) (Härenstam et al., 2000). Between 1994 and 1997 the most common characteristics of changes in the organisations were structural changes of the work organisation, changes of the production process and increased demands for competence, but also decreased size of staff. In the MOA analysis it was found that changes could be perceived either as threatening or enhancing. The negative changes included an increased workload and decreased possibilities to adjust work and family interface. Increased opportunities for development and control were examples of positive consequences. Men and women generally reported similar consequences.

The way in which a change in Swedish working conditions from 1994 to 1998 influenced the prevalence of neck/shoulder disorders in 1998 has been analysed (Stockholms läns landsting, 1999). Decreased control over working conditions, decreased social support at work, decreased variation of work tasks and an

increased workload were factors associated with disorders in the neck/shoulder region, more among women than among men.

The experience of being affected by changes without being able to influence anything, or seeing how skills that used to be of importance lose their significance, seems to be associated with seeking care for neck/shoulder pain. In study IV more individuals reported improved than worsened working conditions. The only exception was that the amount of VDT work had increased. It seems that for the small number of individuals for whom the work had become more demanding, the risk of developing neck and shoulder pain also increased.

Perceived physical exertion

In all the studies included in this thesis, high *perceived* physical exertion was associated with neck/shoulder pain and disorders, especially among women; this was also found in another study among female nursing personnel (Josephson et al., 1997). In study V high perceived exertion was the only physical variable for which the results pointed towards an association to neck/shoulder disorders. No concordance seemed to exist between high perceived physical exertion and work in awkward working positions, percentage of the working day spent doing the same movements with the hands consecutively, and the distribution of work over the day. Instead loss of authority over how the work should be done, short work cycles and deteriorated psychosocial conditions seemed to contribute to the fact that the participants rated their physical exertion higher in the new workplace. It has been found that machine-paced work tasks are more stressful than non-paced tasks (Salvendy et al., 1981). Increased musculoskeletal symptoms of the upper limbs were seen after introduction of the flow-line in fish-fillet plants (Ólafsdóttir et al., 1998). It seems that self-rated physical exertion includes conditions of relevance for the development of musculoskeletal disorders, which are difficult to measure physically in the workplace, and also reflects the perception of the workload. However, a person suffering from musculoskeletal disorders may perceive the physical workload to be higher than a healthy person. Efforts have been made to reduce the risk of getting biased results due to current health status, by using different questionnaires for disorders and exposures (Study III) and by not connecting the estimates of physical exertion to musculoskeletal disorders in the questionnaire. Moreover Torgén et al found no difference in test-retest reliability between subjects with and without low back symptoms regarding perceived exertion (Torgén et al., 1997).

Reliability and validity

Exposure data

The test-retest reliability of self-reported physical exposure data was studied by Torgén et al. using the REBUS material (Torgén et al., 1997). Even regarding conditions 20 years back in time the reliability for work-related conditions was regarded to be sufficient for use in further analyses (correlation coefficient, ri,

0.50-0.98). The high reliability was probably due to the design of the questionnaire, in which the questions were anchored to the subject's occupation at different time periods. In contrast, in another Swedish study, where no such anchoring was used, markedly lower test-retest reliability was achieved for similar questions (Wiktorin, 1995). The leisure-time exposure data did not all have the same reliability, but items selected for use in study III proved to be acceptable (ri 0.51-0.76). For questions about physical exercise the test-retest reliability also was acceptable (ri 0.51-0.75) (Torgén et al., 1997). Long-term recall of participation in physical activity has been assessed in another questionnaire study and found reliable with a recall interval of up to 10 years (Blair et al., 1991). The inter-method reliability of the MUSIC material was tested by combining self-reports with interview data regarding some physical conditions asked for by both methods regarding the same time period. Some differences were found, but no differential misclassification regarding reports from cases and controls seemed to exist (Wiktorin et al., 1999).

The validity of questions used in the REBUS-93 study was evaluated in another group of subjects against questions and measurements made six years earlier (Torgén et al., 1999). For questions used in study III the validity was found to be satisfactory for use in epidemiological studies.

The self-reported data in study V could be validated against measurements and computerised on-line registrations from observations. The results showed that the operators were able to tell the direction of the change in workload. Regarding some items, they were also able to tell about the magnitude of exposure and also the magnitude of change. In spite of the deteriorated psychosocial conditions the participants in study V were able to estimate a decrease in physical working conditions. This indicates that the results were not heavily biased by the experience of deteriorated musculoskeletal health and disappointment with how the intervention was conducted.

Regarding psychosocial exposure data derived from interviews in the REBUS-93 study, inter-rater reliability was found to be good for all exposures used in study III (Kappa values of at least 0.40 and for many items more than 0.75), except for monotonous (not necessarily repetitive) work (Bildt Thorbjörnsson et al., 1999b).

Outcome data

The test-retest reliability of self-reports regarding sick leave and medical consultation was found to be high (Kappa values >0.60, mostly >0.75) (study I and study II), and the average discrepancy regarding the year of onset of the disease was less than 2 years (study III). No statistically significant differences were found in reliability of data early in the time period compared to recent data (study I). These results are in concordance with results from another study about test-retest reliability concerning medical history, participation in exercise, and musculoskeletal symptoms (Franzblau et al., 1997).

In study I the validity of retrospectively collected self-reported sick-leave data was found to be sufficient to be used as a measure of musculoskeletal morbidity in analyses of associations with work-related conditions. The validity of the case and control status in study III could be examined in part in the sub-group (n=269) of the study group who lived in the county of Stockholm in 1990-1993, using information from study I. None of the "controls" had any registered sick leave for neck/shoulder disorders, and all subjects with registered sick leave for neck/shoulder disorders in 1990-1993 had been identified as cases in study III.

Using retrospective data introduces a risk that recall errors may bias the results. There may be an opportunity for the probabilities of misclassifications of exposure and outcome to be interdependent (Rothman & Greenland, 1998). This question has been examined directly in the REBUS study group and no signs of any such dependence were seen (Toomingas et al., 1997). No influence from ongoing neck/shoulder disorders on self-reports was found in the included studies. This is in concordance with results derived from another study on the REBUS material. Only minor differences regarding exposure recall 24 years afterwards were found between subjects with and without current neck/shoulder disorders (Köster et al., 1999).

The fact that most of the cases occurred during the last part of the time period in the REBUS study may either be due to an increasing rate of occurrence of neck/shoulder disorders with increasing age (Tuomi et al., 1991); to memory problems (Public Health Service Publications, 1965); to a "telescoping effect" (Neter et al., 1964); to changes in working life conditions; or to the fact that self-reported pain was only included in the multi-part case definition during the last 12 months in study III. However, the difficulty of remembering has most likely biased the relative risks observed towards unity, rather than revealed non-existent risk factors.

Different sources of information regarding neck/shoulder pain and disorders have been used in this thesis. Results in study III regarding risk indicators for neck/shoulder disorders were derived from analysis where cases were defined by either medical consultation, sick leave or reported symptoms. When these results were compared to those obtained when the analysis were restricted to those who had been identified by medical consultation or sick leave, only small differences were found regarding the relative risk. Therefore the results in this thesis is not supposed to be heavily biased by differences in case definitions. However no analyses could be done about differences in cases identified by sick leave and medical consultation due to the small number sick leave reports (the REBUS study). Furthermore the focus in this thesis is not to highlight differences in care-seeking behaviour, but rather to investigate the reasons for developing upper limb pain. In this context it is of less interest to analyse why people act in different ways. Disorders and pain from neck and shoulders were mostly analysed together, as there is a reciprocal influence from these areas (Josephson et al., 1997; Ljungdahl et al., 1991), and it is therefore difficult for people to separate symptoms.

Low back and neck/shoulder pain
Studies have been performed concerning risk factors for development of low back pain, based on both the REBUS and MUSIC materials. As for the neck/shoulder region interactive effects were seen between work-related factors and leisure-time factors (Bildt Thorbjörnsson et al., 1998) and between physical and psychosocial work-related factors (Bildt Thorbjörnsson et al., 1999a; Vingård et al., 2000). While the impact from physical factors mostly differed, influence over work conditions among women, and poor social relations among men, seemed to be of relevance for the incidence of both neck/shoulder and low back pain.

Relevance in society

Neck/shoulder disorders and pain cause considerable and increasing problems in most countries, especially in the industrialised and post-industrialised parts of the world. Low back disorders and pain has been investigated in many studies, but it is not so often that upper limb pain and disorders has been the issue.

For the patient suffering from neck/shoulder pain information about risk factors can be found in this thesis. Especially the impact of repetitive and monotonous work should be noticed. Interactive effects, more often than exposure to single factors, seemed to contribute to the development of upper limb musculoskeletal pain and disorders. One consequence of this is that considerable relief could be gained, even if only one of the included factors is removed.

Caregivers should try to get information from the patient about different conditions, both from work and leisure-time. Conditions which existed some time ago should also be given attention, in order to be able to evaluate if the patient has been exposed for a long or a short time, and if there have been any recent changes in exposure.

For decision-makers in companies and for politicians, knowledge about the impact of monotonous work and psychosocial factors on neck/shoulder disorders will hopefully lead to new approaches. Economic considerations concerning high costs with regard to musculoskeletal disorders should include analyses of work environment conditions, both from a physical and psychosocial viewpoint. The results in this thesis regarding the importance of how an intervention is managed should be useful when strategies for interventions are chosen. The fact that opportunities to use or gain new knowledge and to take part in the decisions at the workplace are associated with neck/shoulder disorders ought to be taken into consideration when the work is organised.

Recommendations for future research

The results in the included studies highlight the importance of including both work-related and non-work-related conditions, physical and psychosocial, as well as factors related to organisation and working time, in studies on neck/shoulder disorders. Data about recent conditions and conditions during about five years prior to the onset of pain should be gathered to make it possible to study the

impact of changes in exposure. The use of individually assessed data on conditions at work is preferable to more generalised and job-title-based data. Self-reports provide usable data if the questions are formulated carefully. Analyses should be made separately for women and men, if possible, and interactive effects of various factors, especially regarding interactions between work-related and non-work-related conditions, should be included. Chronic pain and disorders constitute a major part of the suffering from musculoskeletal illness. Associations between the development and maintenance of chronic pain and different work-related and non-work-related factors, as well as the impact of unemployment and ethnicity, should be studied in the future.

Conclusions

The included studies lend support to the hypothesis that repetitive work with the hands, both at work and during leisure-time, is a risk factor for neck/shoulder pain and disorders. For other physical and also psychosocial exposures the results pointed towards associations, either when the exposure was recently experienced, or if interactive concomitant risk factors were present. Interactive effects between work-related and non-work-related factors associated with neck/shoulder pain and disorders, were frequently observed, especially among women. High perceived physical exertion was consistently associated with neck/shoulder disorders. Perceived physical exertion may be used as a proxy for the total physical load, also including issues difficult to measure with accessible methods. Furthermore, the result indicates that earlier episodes of neck/shoulder disorders have a considerable impact on new episodes of neck/shoulder pain.

Summary

Kerstin Fredriksson. *On causes of neck and shoulder pain in the general population. Epidemiological studies on associations between workload and leisure-time activities, and disorders in the neck/shoulder region.* Arbete och Hälsa 2000:14.

The aim of this thesis was to identify risk factors for neck/shoulder pain and disorders. In accordance with the bio-psychosocial perspective used, both physical and psychosocial factors were studied at work as well as during leisure-time. Potential interactive effects of these factors on neck/shoulder pain and the impact of different lengths of exposure prior to the onset of pain and disorders were also studied. Methodological aspects regarding assessment of physical working conditions and regarding retrospectively collected self-reports of musculoskeletal diseases and disorders have been examined.

The present thesis is based on three separate projects: the REBUS-study, the MUSIC-Norrtälje study and an evaluation of a changed production process at an automobile plant in Sweden. The REBUS and MUSIC study groups were based on the general population.

Repetitive work with the hands, both during work and leisure-time, was revealed to be the factor most constantly associated with incidence of neck/shoulder pain and disorders. Plausibly a causal relationship exists, which is mainly evident among women. Combinations of factors seem to be of high relevance for the occurrence of upper limb disorders and pain. Deterioration, especially regarding psychosocial factors, contributed more to the incidence of neck/shoulder pain than prevailing demanding psychosocial and physical conditions. A high perceived workload was constantly associated with the incidence of neck/shoulder pain and disorders. When subjects perceive the physical exertion, aspects such as authority over work and length of work cycles seem to be of greater importance than awkward working positions, and distribution of work over the day. The result also indicates considerable impact from earlier episodes of neck/shoulder disorders on new episodes of neck/shoulder pain.

Self-reports regarding visits to caregivers and sick leave were found to be reliable and valid for use as outcome data in epidemiological research. Subjects were able to adequately estimate changes in physical working conditions.

Considering the results in this thesis, future studies should include both physical and psychosocial conditions from work and leisure-time, as well as organisational working conditions. Interactive effects and the impact of changing working conditions should be included in the analyses, made separately for men and women if possible. Questionnaire-based data provide usable information if the questions are formulated carefully.

Key words: Bio-psychosocial perspective, interactions, occupational, non-occupational, validity, reliability, changes, perceived physical workload, retrospective, gender.

Sammanfattning (summary in Swedish)

Kerstin Fredriksson: *On causes of neck and shoulder pain in the general population. Epidemiological studies on associations between workload and leisure-time activities, and disorders in the neck/shoulder region*. Arbete och Hälsa 2000:14.

Avhandlingens huvudsyfte var att identifiera fysiska och psykosociala riskfaktorer för utvecklandet av smärta och besvär från nacke och skuldror. Speciellt arbetsrelaterade förhållanden studerades men även information om förhållanden på fritiden och från studiepersonernas sociala liv inkluderades. Följande frågeställningar studerades: Finns det någon enskild faktor som har stor inverkan på utvecklandet av smärta och besvär i nacke/skuldror? Vilka faktorer samverkar och i vilken grad? Påverkar exponeringstidens längd risken att insjukna, och vad betyder en försämring av arbetsförhållandena? Kan vi lita på självrapporterade data om sjukskrivning och besök hos vårdgivare på grund av smärta och besvär i nacke/skulder? Är enkätsvar angående förändringar av fysiska förhållanden trovärdiga? Vilka faktorer påverkar hur fysiskt ansträngande en arbetssituation upplevs?

Avhandlingen baserades på resultat från tre olika projekt: REBUS-studien, MUSIC-Norrtälje-studien och en utvärdering av en förändring av produktionsdesignen på en bilfabrik i Sverige.

a) Studiebasen i REBUS-studien bestod av ett befolkningsurval av 2579 personer, bosatta i Stockholms län, som undersöktes för första gången 1969. Av dessa kallades 783 till en förnyad undersökning 1993 och 484 (43-59 år gamla 1993) kom. De fyllde i frågeformulär och deltog i intervjuer med en psykolog. Förhållanden under tiden 1970-1993 kartlades både vad gällde förhållanden i arbete och på fritiden. Dessutom svarade alla deltagarna på frågor om besök hos vårdgivare och sjuskrivning för besvär i rörelse och stödjeorganen under hela den aktuella perioden. För de i studiegruppen som var bosatta i Stockholm med omgivning 1993 erhölls också uppgifter från försäkringskassan angående registrerad sjukskrivning för perioden 1990-1993.

b) MUSIC-Norrtälje-studien är en fall-kontroll studie där studiebasen utgjordes av invånare i Norrtälje kommun, 20-59 år gamla, som inte arbetade eller studerade utanför kommunen, inalles ca 17 000 personer under en 3 årsperiod. Fallen utgjordes av de som under studietiden sökte vård eller behandling hos någon av 60 vårdgivare av olika kategorier som var verksamma i området. Kontrollerna, matchade vad det gäller ålder och kön, valdes slumpmässigt ur den aktuella studie basen med hjälp av befolkningsregister. Varken fall eller kontroller skulle ha sökt vård för nack/skulderbesvär under de närmast föregående 6 månaderna. I den studie som ingår i denna avhandling inkluderades 392 fall och 1511 kontroller. Alla deltagarna undersöktes fysiskt och fallen delades i två grupper, med och utan pågående besvär. De flesta fallen undersöktes inom 2 veckor från besöket hos

vårdgivare. Deltagarna fyllde också i ett frågeformulär om förhållanden på arbetet och på fritiden, för närvarande och för 5 år sedan. Alla blev också intervjuade av en psykolog och de psykosociala förhållandena inom den närmaste 5 årsperioden kartlades.

c) På en tätningsavdelning för bilkarosser i en svensk bilfabrik beslöt man att förändra produktionssättet och gå ifrån ett sk. ”line-out-system” med parallella arbetsstationer där hela bilen tätades, till att arbeta vid en produktionslinje där en operatör gör samma moment på alla bilar. Anledningen till förändringen var av produktionsteknisk och ekonomisk natur men man tog även hänsyn till ergonomiska aspekter. En utvärdering av förändringen ur ett ergonomiskt perspektiv genomfördes. En grupp av 58 operatörer (20-63 år) som arbetade på avdelningen både före och efter förändringen utgjorde studiegruppen. Dessa, liksom en kontrollgrupp om 33 operatörer (21-52 år) från en annan avdelning med likartat arbete där ingen förändring skedde under den aktuella tiden, svarade på frågor om fysiska och psykosociala arbetsförhållanden samt om smärta och värk i rörelse- och stödjeorganen. Ett formulär fylldes i ca 2 månader före förändringen, och ett ¾ år efter interventionen. Dessutom undersöktes de fysiska förhållandena före och efter förändringen för en mindre grupp av operatörer vid tätningsavdelningen med hjälp av direkta mätningar och en datoriserade observationsmetod.

Ett av huvudresultaten i denna avhandling var att ensidigt upprepade hand- och fingerrörelser, både på arbetet och på fritiden, med största säkerhet kan ses som en viktig riskfaktor för att utveckla besvär i nacke och skuldror. Kombinationer av faktorer, arbets- och fritidsrelaterade, fysiska och psykosociala, var ofta förenade med förhöjda risker. Försämrade arbetsförhållanden, speciellt vad det gäller psykosociala faktorer, utgjorde också en ökad risk. Vad det gäller fysiskt tungt arbete, arbete över axelhöjd och tunga lyft, tycks det som om många med tiden lärde sig att hantera situationen. En annan orsak till att risken inte ökade med exponeringstidens längd kan vara att de med besvär slutade i det aktuella arbetet. Detta senare resulterade då i en s.k. ”healthy workers effect” dvs. bara de som inte utvecklar besvär blev kvar.

I de multivariata analyserna framkom att tidigare besvär i nacke och skuldror var starkt förknippat med att åter utveckla liknande besvär. Detta gällde också besvär upp till 23 år tidigare i livet. Motion gav ingen skyddande effekt. De som skattade sitt arbete som fysiskt ansträngande löpte en större risk att utveckla besvär från övre extremiteten än de som skattade sitt arbete som mindre ansträngande. Rökning visade sig öka risken att utveckla nack/ skulderbesvär och smärta bland kvinnor, men endast i en av studierna. Övertids- och skiftarbete liksom socioekonomisk status hade också inverkan, men i varierande grad.

Reliabiliteten för självrapporterade uppgifter om besök hos vårdgivare och sjukskrivning visade sig god bland de 66 deltagarna i REBUS undersökningen som fyllde i frågeformuläret två gånger. De uppgifter som deltagarna i REBUS undersökningen lämnat i enkäten rörande sjukskrivning kunde valideras mot data från försäkringskassan för tiden 1990 –1993. Det visade sig att man till en viss del glömt att man varit sjukskriven och i vissa fall för vad, men detta var bara i

undantagsfall påverkat av om man var utsatt för olika exponeringar eller om man hade pågående besvär i rörelse- och stödjeorganen.

I studien av förändringen på bilfabriken insamlades data om arbetsställningar och arbetsrörelser med olika metoder. När enkätsvaren från de två undersökningstillfällena kombinerades visade det sig att deltagarna hade kunnat bedöma tiden de arbetade i olika arbetsställningar och i olika slag av arbete på ett adekvat sätt. En annan intressant iakttagelse var, att trots att man bedömde att den faktiska tiden man arbetade i ansträngande arbetsställningar hade minskat så bedömde man arbetet som fysiskt mer ansträngande efter förändringen. Det tycktes som om korta arbetscykler och bundenhet vid arbetsplatsen och brist på inflytande i högre grad än ansträngande arbetsställningar hade betydelse för hur fysiskt tungt man skattade arbetet.

Resultaten i denna avhandling belyser vikten av att inkludera både fysiska och psykosociala aspekter, både från arbetsliv och fritid, liksom arbetsorganisatoriska förhållanden i analyser av nack/skuldersjuklighet. Kvinnor och män bör om möjligt analyseras i separata grupper då det visat sig, i studier som ingår i denna avhandling och i andra studier, att det finns en könsskillnad vad det gäller riskfaktorer för att utveckla besvär i nacke och skuldror. Datainsamlingen bör inte inskränka sig till att gälla förhållanden det närmaste året, utan även beröra en tidsperiod av åtminstone 5 år tillbaka i tiden. Resultaten i denna avhandling vad det gäller reliabilitet och validitet av retrospektivt insamlade frågeformulärs data tyder på att sådana data kan användas i epidemiologiska studier om frågorna formuleras med omsorg. Detta kan vara av stor ekonomisk och praktisk betydelse för studier i framtiden. Framtida studier om besvär och smärta i nacke och skuldror bör också inkludera studier om kroniska besvär och om inverkan av etnicitet och arbetslöshet, förhållanden som av olika skäl inte berörts i denna avhandling.

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Appendix 1

Physical conditions at work	Measurement scale	Cut-off point for potential risk
Perceived general exertion	Borg RPE scale 6-20 (III, IV) 0-14 (V)	III: ≥12 IV: ≥14
VDT work	Continuous scale	≥50% of the time
Work with hand-held vibrating tools	Continuous scale	III: ≥16% IV:≥5%of time
Work including frequent hand/finger movements many times per minute (at least 2 hours per day, study III and IV¸ V: ≥45 min/day)	5-point scale[1)]	III: >1 IV: ≥4
Work with hands above shoulder level (at least 1/2 hour per day, study III and IV¸ V: ≥45 min/day)	5-point scale[1)]	III: ≥3 IV: ≥ 4
Bent or twisted body posture several times per hour (in the same way);V: ≥45 min/day	5-point scale[1)]	III: ≥3 IV: ≥ 4
Lifting/carrying loads between 5 and 15 kg	5-point scale[1)]	III: ≥3 IV: ≥ 4
Lifting/carrying loads exceeding 15 kg	5-point scale[1)]	III: ≥3 IV: ≥ 4
Physical factors in leisure-time		
Use of spare time for housework	Continuous scale	IV:≥75%
Perceived general exertion	Borg RPE scale 6-20	III:≥ 12
Precision work more than 2 hours per day	5-point scale[1)]	III: ≥ 3
Frequent hand/finger movements many times per minute.	5 point scale[1)]	III: ≥ 3

[1)] 1= hardly ever
2=1-3 days per month
3=1 day per week
4=2-4 days per week
5= each day

III = Study III; IV = Study IV; V = Study V

Appendix 2

Psychosocial conditions at work and response categories (potential risk) in the REBUS-93 study.

Commitment and satisfaction

1. Commitment to work tasks: Are you committed to your work tasks?
   Five alternatives from “very much” to “not at all” (“to some extent” or less)
2. Commitment to the social aspects of work: Are you committed to the social part of your
   work? Five alternatives from “very much” to “not at all” (“to some extent” or less)
3. Commitment to colleagues: Are you committed to your colleagues?
   Five alternatives from “very much” to “not at all” (“to some extent” or less)
4. Work satisfaction: Are you satisfied with your working conditions?
   Five alternatives from “very much” to “not at all” (“to some extent” or less)

Work content

5. Demands for new knowledge: Do you need to gain new knowledge now and then in order to manage
   your tasks in a good way?
   Four alternatives from “very much” to “not at all” (“to a certain degree” or less)
6. Decision latitude: Do you have opportunities to decide when or how you perform your work
   tasks?
   Four alternatives from “very many” to “none at all (to a small degree or less)
7. Opportunities for development: Are there development opportunities in your work?
   Three alternatives from “many” to “none at all” (“few” or “none at all”)
8. Monotonous work: Do you regard your work tasks as similar during the working day?
   Three alternatives from “yes, to a certain degree” to “not greatly varying” (some or not at all)
9. Opportunity to influence work pace: Is it possible for you to influence your work pace?
   Three alternatives: “very much”; “only a little”; or “not at all” (“somewhat” or less)
10. Time pressure: Do you work under time pressure on a normal working day?
    Five alternatives from “0% of the day” to “100% of the day” (75% or more)

Interruptions in work

What kind of interruptions occur within your different work tasks?

11. Social interruptions (unclear instructions, people who disturb you, phone calls that disturb you,
    difficulties in reaching your employer, and so on)

Three alternatives from “seldom” to “often” (“often”)

12. 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” (“often”)

Accident risks

13. Risk of accidents: How great is the risk of accidents at work?

Three alternatives from “very small” to “great” (great)

Social interaction

14. Dependence on colleagues: Are you dependent on your colleagues for managing your work tasks?

Four alternatives from “absolutely” to “not at all” (“to a lesser degree” or “not at all”)

15. 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 a lesser degree” or “not at all”)

16. Social support from superior: Do you receive the support you need from your immediate superior to manage your work tasks?

Four alternatives from “absolutely” to “not at all” (“to a lesser degree” or “not at all”)

17. Social interaction with colleagues after work: Do you socialise with your colleagues?

Four alternatives from “very much” to “not at all” (“somewhat” or less)

Working hours

18. Shift work: What are your working hours?

Seven alternatives from “daytime” to “night work” (all other working times than daytime)

19. Overtime work: Do you work overtime?

Five alternatives from “not at all” to “a great deal” (“rather a lot” or “a lot”)