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Back and neck pain. Epidemiological studies on some risk factors and treatments, including Naprapathic manual therapy

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To Siri and Nanna

ABSTRACT

Introduction: Back and neck pain are common and constitute the main cause for persistent pain in the population. The knowledge about the etiology and about the effect of different treatments that are offered for back and neck pain is not fully understood, with a few exceptions.

Objectives: The overall aim of this thesis was to give epidemiological aspects of some potential risk factors for back and neck pain, as well as on manual treatment of such pain. Objectives in Studies I and II were to expand the knowledge about life events and coping style, and how they affect the risk of low back and/or neck/shoulder pain. In Study III, the objective was to investigate how smoking and alcohol consumption, respectively, affect the risk of long-term sick leave due to back or neck pain. The objective in Study IV was to evaluate the effects of the in Scandinavia commonly occurring naprapathic manual therapy for patients with non-specific pain in the back and/or neck.

Materials and Methods: Studies I and II are based on the population-based MUSIC-Norrtälje case-control study that comprised men and women 20-59-years-old, living in and not working outside a municipality in Sweden. Cases (n=1,148) were subjects from the study base who sought care for a new episode of low back and/or neck/shoulder pain during the study period 1993-1997. Controls (n=1,700) were selected as a stratified random sample from the study base with consideration taken for sex and age. Life events and critical life changes were measured by semi-structured interviews, and the coping style was measured with a questionnaire. Study III is based on the HAKuL-Study, a three-year prospective cohort study. New periods of sick leave ($\geq$ 28 days) due to back and/or neck pain were consecutively reported during three years from baseline, among 6,532 persons that in questionnaires at baseline had reported on their smoking and alcohol habits. Study IV is based on the BJÖRN-Trial, a randomized controlled trial with 409 patients with non-specific back and neck pain. The interventions compared were naprapathy, including spinal manipulation/mobilization, massage and stretching (*Index Group)*, and support and advice on staying active and on pain coping strategies, according to the best scientific evidence available, provided by a physician (*Control Group)*. Questionnaires were mailed to all participants after 3, 7 and 12 weeks, and the two groups were compared using the "intention to treat" principle.

Results and conclusions: Having experienced at least two life events or critical life changes during the preceding five years was associated with an increased risk of neck/shoulder pain. A covert coping style was more common among women and was associated with an increased risk of neck/shoulder pain among women, but not among men. In general, no associations were observed in relation to the risk of low back pain. An interaction effect between a covert coping style and psychosocial stress was observed among women (Studies I and II). Regarding the risk of long-term sick leave due to back and neck pain, smoking involved an increased risk, whereas alcohol consumption tended to involve a decreased risk (Study III). Naprapathic manual treatment were statistically and clinically significant more effective than evidence-based advice on staying active and on pain coping strategies for non-specific back and neck pain, after 7 and 12 weeks (Study IV).

Key words: Neck pain, low back pain, coping style, life change events, life style, musculoskeletal manipulations, case-control study, cohort-study, randomized controlled trial.

SAMMANFATTNING

Introduktion: Att ha ont i ryggen och nacken är mycket vanligt. De allra flesta får ont någon gång i livet men besvären är oftast övergående utan att man behöver någon behandling eller annan åtgärd. Men relativt många utvecklar långvariga besvär som blir en stor börda för både individ och samhälle. Det är dock mycket ovanligt att besvären kan kopplas till någon allvarlig sjukdom. Kunskapen om vad som orsakar rygg- och nackbesvär, samt om effekten av de behandlingar som erbjuds är bristfällig och mer forskning behövs för att kunna förhindra uppkomst samt behandla besvären på ett effektivt sätt.

Syfte: Det huvudsakliga syftet med avhandlingen är att ge epidemiologiska aspekter på några potentiella riskfaktorer för rygg- och nackbesvär, samt på manuell behandling av sådana besvär. Syftet i studie I och II var att utöka kunskapen om levnadshändelser och coping-strategier, och om hur de påverkar risken att utveckla besvär i ländrygg och nacke/skuldra. I studie III var syftet att undersöka hur rökning och alkoholkonsumtion påverkar risken att bli långtidssjukskriven för rygg och nackbesvär. Syftet i studie IV var att utvärdera effekten av den i Skandinavien vanligt förekommande manuella behandlingsmetoden naprapati för ospecifika besvär i rygg och nacke.

Material och metoder: För att uppfylla målen med avhandlingen har tre olika svenska datainsamlingar analyserats. I studie I och II användes data från den populationsbaserade fall-kontrollstudien MUSIC-Norrtälje som inkluderat män och kvinnor i åldern 20-59 år, som bodde i Norrtälje kommun, men inte arbetade utanför densamma under perioden 1993 – 1997. Fallen (n=1148) i studien utgjordes av dem i studiebasen som sökte vård för besvär i ländrygg eller nacke/skuldra hos någon av de 75 identifierade vårdgivarna i kommunen. Dessa utgjordes av läkare, naprapater, sjukgymnaster och kiropraktorer så väl som av alternativa vårdgivare som massörer, och homeopater. Kontrollgruppen utgjordes av personer som med hjälp av befolkningsregistret slumpmässigt valdes ur studiebasen, matchade på ålder och kön. Exponeringen för levnadshändelser mättes med semistrukturerade intervjuer, och olika typer av copingstrategier mättes med ett frågeformulär om hur man reagerar vid orättvis behandling på jobbet. Att ha en dold copingstrategi innebär att man exempelvis reagerar på att bli oskyldigt anklagad för att man gjort något fel genom att låta det passera utan att säga något, eller att man mår dåligt, och kanske senare blir på dåligt humör och låter det gå ut över någon annan. I studie III analyserades data från den treåriga prospektiva kohortstudien HAKuL som genomfördes bland personalen i sex kommuner och fyra landsting runt om i Sverige. En ny period av sjukskrivning ($\geq$ 28 dagar) för besvär i rygg och nacke rapporterades bland de 6532 personer som inkluderades i studien. Frågor om rökning och alkoholvanor hade besvarats av studiepersonerna i enkäter vid baslinjen. I studie IV, en randomiserad kontrollerad studie kallad BJÖRN-studien, inkluderades 409 personer med ospecifika besvär i rygg och nacke. Dessa fördelades slumpmässigt mellan två olika behandlingsgrupper, naprapatbehandling (en kombination av manuella behandlingar som massage, töjningar och spinal manipulation/mobilisering) eller evidensbaserad rådgivning av läkare. Rådgivningen baserades på konsensus i evidensbaserade sammanställningar och riktlinjer: det viktigaste för att tillfriskna från besvären är att hålla sig aktiv, med arbete och träning i samma eller större omfattning än innan besvären startade, samt råd om hur man skall förhålla sig till smärtan. Grupperna jämfördes sedan genom att enkäter med frågor om bl.a. smärta, funktion, och upplevd förbättring/försämring skickades ut efter 3, 7 och 12 veckor till alla studiedeltagare.

Resultat och slutsatser: Studie I och II visade att risken för att få ont i nacke/skuldra ökade om man hade upplevt minst 2 levnadshändelser de senaste fem åren jämfört med dem som hade upplevt levnadshändelser i mindre omfattning. En s.k. dold copingstrategi, var vanligare hos kvinnor än hos män. En dold copingstrategi medförde en större risk för att få ont i nacke/skuldra hos kvinnor i jämförelse med en öppen coping strategi, men inte hos män. Dessutom verkade copingstrategier ha betydelse för hur kvinnor påverkas av stress när det gällde besvär i nacke/skuldra. Ingen tydlig risk för ländryggsbesvär kunde observeras. Studie III visade att när det gäller risken för långvarig sjukskrivning för rygg och nackbesvär medförde rökning en ökad risk. Att dricka måttliga mängder av alkohol verkade istället ha en skyddande effekt mot långtidssjukskrivning för sådana besvär. Studie IV visade att behandling med naprapati var statistiskt och kliniskt signifikant mer effektivt än behandling med evidensbaserad rådgivning av läkare, avseende smärta, funktionsnedsättning och upplevd förbättring, efter 7 och 12 veckors uppföljning.

LIST OF PUBLICATIONS

I. **Skillgate E**, Vingård E, Josephson M, Theorell T, Alfredsson L.
Life events and the risk of low back and neck/shoulder pain of the kind people are seeking care for: Results from the MUSIC-Norrtälje case-control study.
J Epidemiol Community Health, 2007, 61, 356-61.

II. **Skillgate E**, Vingård E, Josephson M, Theorell T, Alfredsson L.
The role of coping style in the onset of a new episode of low back and neck/ shoulder pain. Results from the Swedish MUSIC-Norrtälje case-control study.
Psychotherapy and Psychosomatics, 2007, 76, 253-55.

III. **Skillgate E**, Vingård E, Josephson M, Holm LW, Alfredsson L.
Smoking, alcohol and the risk of long-term sick leave due to back and neck pain. Results from a three-year follow-up study.
Submitted in September 2007.

IV. **Skillgate E**, Vingård E, Alfredsson L.
Naprapathic manual therapy or evidence-based care for back and neck pain. A randomized, controlled trial.
Clinical J of Pain, 2007, 23, 431-9.

CONTENTS

LIST OF ABBREVIATIONS

AP	Attributable Proportion
AUDIT	Alcohol Use Disorders Identification Test
BJÖRN	Bra hjälp för rygg och nacke
BMI	Body Mass Index
BP	Back Pain
CI	Confidence Interval
CPQ	Chronic Pain Questionnaire
HAKuL	Hållbar arbetshälsa i kommuner och landsting
IASP	International Association for the Study of Pain
LBP	Low Back Pain
LEDS	Life Events and Difficulties Schedule
MND	Mechanical Neck Disorders
MOB	Spinal Mobilization Therapy
MUSIC	Musculoskeletal Intervention Centre
RCT	Randomized Controlled Trial
RD	Risk Difference
RR	Rate Ratio, Relative Risk
SBU	Swedish Council on Technology Assessment in Health Care
SCTM	Soft and Connective Tissue Manipulations
SF-36	The MOS 36-item Short Form Health Survey
SMT	Spinal Manipulative Therapy
SRRS	Social Readjustment Rating Scale
TENS	Transcutaneous Electrical Nerve Stimulator
WAI	Work Ability Index
WDQ	Whiplash Disability Questionnaire

1 INTRODUCTION

A large proportion of the population in Sweden and in most other countries suffers from pain. A survey of long lasting pain in Europe (n=46,394) with the aim of exploring the prevalence, severity and impact of long lasting pain found that 19% of the adult Europeans had long lasting pain of moderate to severe intensity that seriously affected the quality of their social and working lives (1). Almost half of these persons suffered from back pain, and one in five had head or neck pain. Even if the natural history of back and neck pain often is good, many get recurrent pain and some develop long-lasting disabilities that have important consequences for that person's life, as well as for society. The Swedish Council on Technology Assessment in Health Care (SBU) found substantial evidence for a strong association between living with long lasting pain and quality of life (2).

It is considered important that care for back and neck pain mainly shall be evidence-based. Evidence is a concept used to describe the knowledge level used when research results are summarized. The word "evidence" (from the Latin *evidentia*) refers to something that is judged to show that a certain circumstance exists. In the concept of *evidence-based medical care* the evidence consists of systematic observations that fulfill scientifically reliable criteria in such a way that they are considered to be the "best available evidence". It is important to note that the fact that there is no evidence for the effectiveness of a certain treatment is not in itself a value judgment. It merely means that a treatment's value is unclear, and that more research needs to be done before its effectiveness can be assessed. Common treatments for back and neck pain are manual treatments as spinal manipulations/mobilization and massage, or a combination of different manual treatments. In Sweden, Norway and Finland it is common that patients with pain in the back and neck get naprapathic manual treatment. Hence, it seemed urgent to evaluate this particular therapy since that had never been done before in a scientific way.

Research in back and neck pain is important and different research methods are used depending on the research questions. Epidemiology employs a variety of research designs, and it has been defined as "the science of occurrence of diseases in human populations." Disease occurrence is measured and related to different characteristics of individuals or their environments. The word epidemiology consists of the Greek words *epi* = among, *demo*s = people and *logos* = doctrine, and thus means the doctrine of what is among or happening to people (3).

The fact that back and neck pain are multifactorial, that both the definition and diagnosis of back and neck pain are problematic, and that both the exposure and the outcome are often self-reported, gives that it is a methodological challenges to perform research in this area. The thesis is written with the aim of giving epidemiological aspects of some potential risk factors for back and neck pain, as well as on manual treatments of such pain, and with the ambition to illustrate some of the research challenges.

2 BACKGROUND

2.1 THE EXPERIENCE OF PAIN

Our ability to feel pain is an important condition for a normal life. But if pain becomes long lasting, it is often a hindrance in everyday life. In al kinds of pain, two main components may be discerned (4). The first is the subjective judge of the pain intensity, localization and duration, and the second includes the emotional, discomfort and distressing experience that the pain brings. Pain is defined by the International Association for the Study of Pain (IASP) as an unpleasant experience that involves the conscious awareness of noxious sensations, hurting and aversive feelings associated with actual or potential tissue damage (5).

Pain is a subjective experience that can have physical as well as psychological origin, and the experience of pain is influenced by many parameters. Wall proposes that the sensation of pain is an awareness of a series of need states (5). The phrase "need state" is also used for reactions such as hunger and thirst. The onset of pain is associated with active avoidance in an attempt to abolish the stimulus. After that phase, a complex series of events start up to optimize the prevention of further damage, including muscle contractions. The next phase is optimal for recovery including rest and immobility and seeking aid and therapy.

There is a strong association between living with long lasting pain and quality of life and decreasing pain results in an increased quality of life (2). In one study, 59% of patients with pain the preceding four weeks found the pain to interfere with everyday life (6). Long lasting pain is associated with other symptoms as depression and anxiety, negative consequences for everyday life at work and outside work, and bad general health. Health-related quality for life of long lasting non-malignant pain patients is among the lowest observed for any medical condition (7).

Back and neck pain is most commonly arising from stimulation of nociceptors in different tissues in the body. But pain may also come up without stimuli of nociceptors, but as a result of pathology within the nervous system, called neuropathic pain. Also very bad psychological conditions are said to be painful.

The pain alleviation process involved in non-medical treatment of pain is complex and not fully understood. The pain may be hampered or blocked by other sensory stimulations as manual therapy, acupuncture or TENS. The anti-nociceptive mechanisms of action of afferent activities are still largely unknown according to Hansson and Lundeberg (5). The afferent activity arising in such treatments has been suggested to block nociceptive transmission in the spinal cord, and the central nervous system.

The human body has several pain modulating systems that are influenced by sensory stimulation or by psychological processes. These may work on several levels in our body, and three principal mechanisms for pain alleviation have been suggested; a) counter irritation acting at the segmental level of the spinal cord, b) activation of central descending pain inhibiting systems, and c) psychological mechanisms (4, 8).

Counter irritation acting at the segmental level of the spinal cord
The introduction of the gate control theory concept for alleviation of pain by Melzack & Wall in 1965 (9) gave one important part of the explanation to how pain may be hampered by non-medical treatments. The model for pain relief, explained in a simplified way, is based on an interaction between large-diameter non-nociceptive afferent fibers and thin nociceptive afferent fibers in the dorsal horn of the spinal cord. Activity in nociceptive afferent fibers can be blocked in the dorsal horn of the spinal cord, before the sensation of pain is forwarded to our consciousness, by stimulation of non-nociceptive afferent nerve fibers (like the stimulation of mechanoreceptors when massage is given).

Activation of central descending pain inhibiting systems
The descending pain controlling mechanisms that originate from the brainstem, may be activated in two ways: by activity in ascending pain systems, as for example nociceptive pain from the musculoskeletal system, or by higher centers in the brain that are influenced by different psychological situations (4).

Psychological mechanisms
There are big individual differences in pain experiences and the reasons for that are not fully understood. They are probably the result of an interaction between endogenous and exogenous factors. Depending on the situation, our endogenous opioid system is altered. When the system is activated, pain is hampered, and when it is inhibited, pain is increased. The system can be altered by psychological processes as expectations, anxiety, worrying, fear, depression, tiredness, calmness, trust, confidence and joy. The evidence is growing that placebo analgesia may involve an opioid-dependent mechanism (5).

2.2 THE DEFINITION OF BACK AND NECK PAIN

Low back pain is usually defined as pain localized below the costal margin and above the inferior gluteal folds, with or without leg pain (sciatica) (10). There is no generally accepted definition of neck pain, but neck pain often means pain localized in the neck and upper thoracic spine (11). Back and neck pain is typically classified as being specific or nonspecific. Approximately 95% cases of back and neck pains have no identifiable cause and are designated as nonspecific (12). No reliable and valid classification system exists for most of these cases even though it is common that clinicians have their own labels on a number of sub-groups of these conditions.

We often divide up pain in the musculoskeletal system into acute, sub-acute, and prolonged pain. Acute pain means pain with a duration of less than 6 weeks; sub-acute is pain with a duration of 6-12 weeks; and prolonged pain is pain for more than 12 weeks (13). Most back and neck pain bouts are temporary, but sometimes they are long-lasting. The transition from acute to prolonged low back pain seems complicated. Many individual, psychosocial, and workplace factors play a role. To avoid a transition to long lasting pain, international guidelines for the treatment of acute low back pain ask for the assessment of so-called yellow flags or psychosocial risk factors during the first 2–6 weeks of pain onset (14).

Serious back and neck pain diseases are rare, and back and neck pain is seldom caused by “red flags” as serious organic diseases such as spinal fractures, cancers,

infections, and cauda equina syndrome caused (12, 15). The probability that a particular case of back pain has a specific cause identified on back radiographs is low (16).

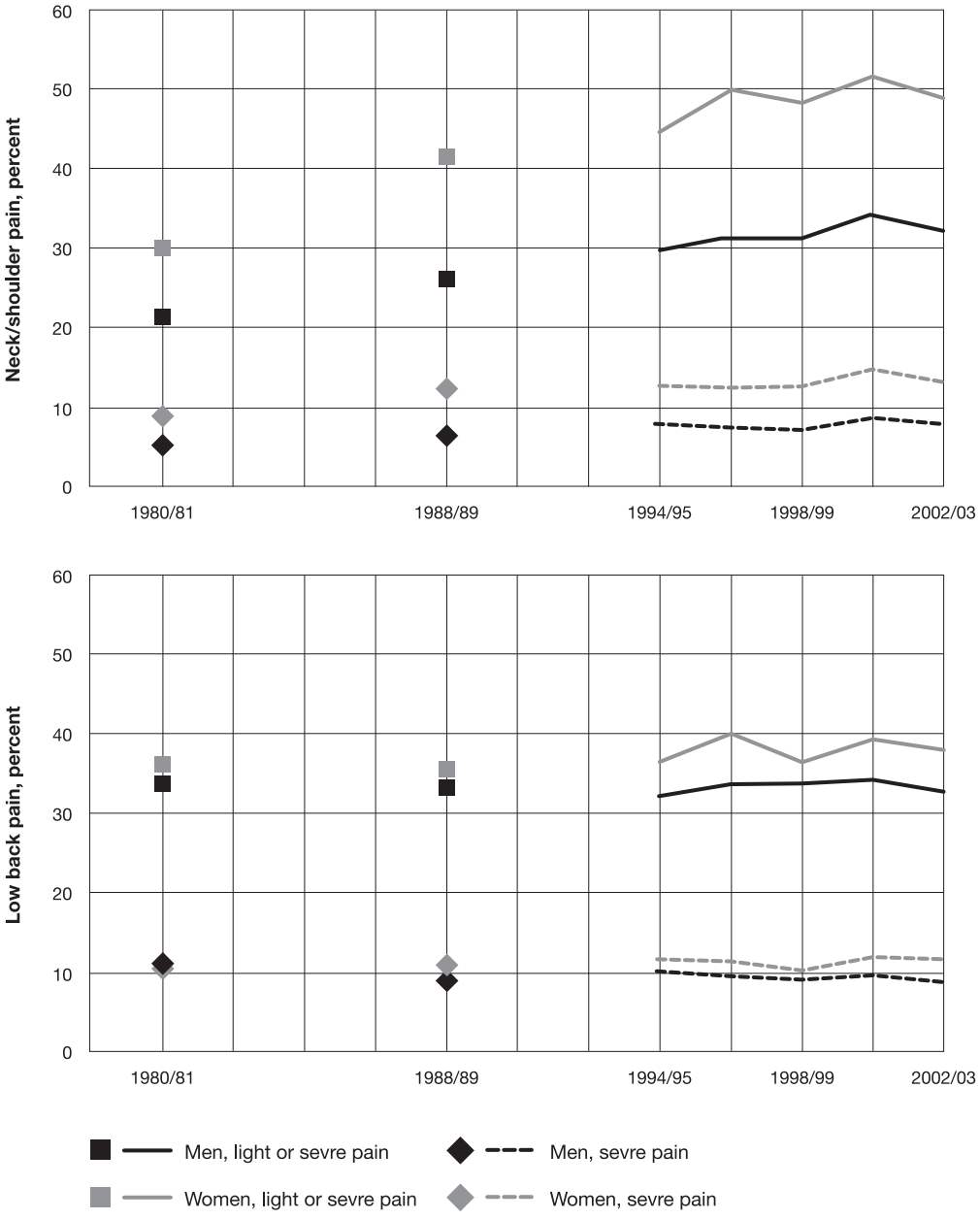
2.3 BACK AND NECK PAIN IN THE POPULATION

Pain in the back and neck are common, it cause great suffering, and have vast economic societal consequences (15, 17-19). There has been an increase in the prevalence of back and neck pain, and in outpatient attendance for back and neck pain during the last decade, and these patients are common in a general practitioner's everyday practice (19, 20). Figure 1 shows the proportion of men and women with self-reported neck/shoulder pain and low back pain in the Stockholm county council in the period 1980-2003, and indicates an increase, at least for neck/shoulder pain (21).

The lifetime prevalence of low back pain is reported to be between 60-70% (15). The economic cost for back pain for society is huge, 29.4 billion Swedish kronor in 1995. The societal costs for back pain are high also in other countries (19, 20, 22).

Neck pain is also common and costly (23), and the lifetime prevalence has been reported to be between 26-71% in different studies (24-27). Long lasting neck pain is frequent in the general population, particularly in women. The annual cumulative incidence of neck pain in the adult population is reported to be approximately 18% (28). The prevalence of neck pain during the previous six months has been found to be 30-54% (29, 30). In a Swedish study 43% of the population reported neck pain, more women (48%) than men (38%) (31). Long lasting neck pain, defined as continuous pain of more than six months' duration, was commoner in women (22%) than men (16%).

Figure 1. The proportion men and women, 16-64 years of age, with pain from neck/shoulder and low back, respectively, in the period 1980 – 2003, standardized for age (21).



2.4 RISK FACTORS FOR BACK AND NECK PAIN

Back and neck pain is considered to have multifactorial etiologies, where many moderate risk factors interact in a complex web of factors in the origin and in the course (32).

The etiology of back and neck pain was studied in hundreds of studies. Unfortunately many were cross-sectional in designs that only show statistical associations between possible risk factors and the prevalence of reported symptoms. That makes it hard to come to conclusions on causality. A way to get an overview of the evidence of risk factors is to read systematic literature reviews. There are several about back pain and some about neck pain, but their conclusions differ to some extent.

Being a woman is associated with neck pain in several studies (33-37), as well as age (the prevalence is highest in middle age) (33, 36-39), and a history of musculoskeletal pain (33-35, 40, 41). Recent twin studies indicate a genetic influence on neck pain (42, 43). There are some reviews on physical and psychosocial risk factors for the onset of neck pain. There was evidence for a positive relationship between the following work-related risk factors and neck pain: neck flexion, arm force, arm posture, duration of sitting, twisting or bending of the trunk, hand-arm vibration, and workplace design (44). Positive evidence was also found for a positive relationship between high quantitative job demands, low social (co-worker) support, low job control, high and low skill discretion, and low job satisfaction and the risk of neck pain (45). Vingård and Nachemson reviewed the literature on work-related influences on low back and neck pain (15). They found that the impact of occupation on low back pain and neck pain exists but is modest, except for extreme working situations for a prolonged period of time without the possibility of changing work tasks. For low back pain, most published investigators report that an association between some types of whole-body vibrations for prolonged periods, frequent bending and twisting of the trunk, frequent heavy lifting, different aspects of poor psychosocial conditions including poor job satisfaction, and low back pain (15).

In a review on psychosocial risk factors at work and in private life, strong evidence was found for low social support in the workplace, and low job satisfaction as risk factors for back pain (46). Insufficient evidence (few studies or inconsistent findings in multiple studies) was found for an effect of a high work pace, high qualitative demands, low job content, low job control, and psychosocial factors in private life.

A review on physical load during work and leisure time found strong evidence for manual materials handling, bending and twisting, and whole-body vibration as risk factors for back pain (47). The evidence was moderate for patient handling and heavy physical work, and the risk of back pain. No evidence was found for an increased risk for back pain from standing or walking, sitting, sports, and total leisure-time physical activity.

Even if different reviews find scientific support that a certain risk factor is causing back or neck pain, the authors often hesitate to state that this is the truth when it comes to the interpretation of the results and to the conclusions. Gordon Waddell has reviewed the results of reviews of risk factors for back pain in his book *The Back Pain Revolution* from 2004 (17). He summarized that most of us are going to get back pain at some time in our lives and that individual risk factors do not make much

difference. He continues that there is nothing in our genes that dictates that they inevitably lead to long lasting pain. Further, he writes that there is little convincing evidence that work is physically harmful to the back, even though many patients and health professionals are firmly convinced that heavy manual work must somehow cause back injury or degenerative changes. However, work may aggravate back pain, whatever its cause, and back pain may make it more difficult to meet certain physical demands. On the contrary work is generally good for people with back pain, according to Wadell.

A way of defining back and neck pain is "sick leave due to back and neck pain." A systematic review on the causes of sick leave was published in 2004 (48), and it was concluded that the knowledge is limited about causes and consequences of sick leave (49). The need for identifying risk factors for long-term sick leave in order to make effective prevention strategies was stated in the report. The evidence on the risk factors of sick leave attributed to back and neck disorders often focuses on work factors (50). Since the etiology of sickness absence is multifactorial, it is also important, however, to investigate other factors as smoking and alcohol consumption. Five studies about the impact of smoking on long-term sick leave due to back or neck pain (51-55) but no study on the impact of alcohol consumption was included in the review. In summary, smoking was not found to significantly increase the risk of sick leave due to back disorders (56). The need for more high quality research on risk factors for sick leave due to back and neck pain, especially concerning women and the impact of lifestyle factors was stated (49).

There are some more recent studies published on the associations between smoking and sick leave. Three studies found a higher risk of sick leave due back pain (57-59). One study based on the HAKuL-Study found smoking to be associated with long-term sick leave regardless of diagnosis (60), and in one study smoking was found to be a predictor for long-term work disability in the musculoskeletal system among physically inactive persons (61). In summary, these more recent published studies suggest that smoking is a risk factor for sick leave due to back pain.

2.4.1 Life events

It has been increasingly established that psychological and psychosocial factors play significant roles in the etiology of long lasting as well as acute back and neck pain (62-64).

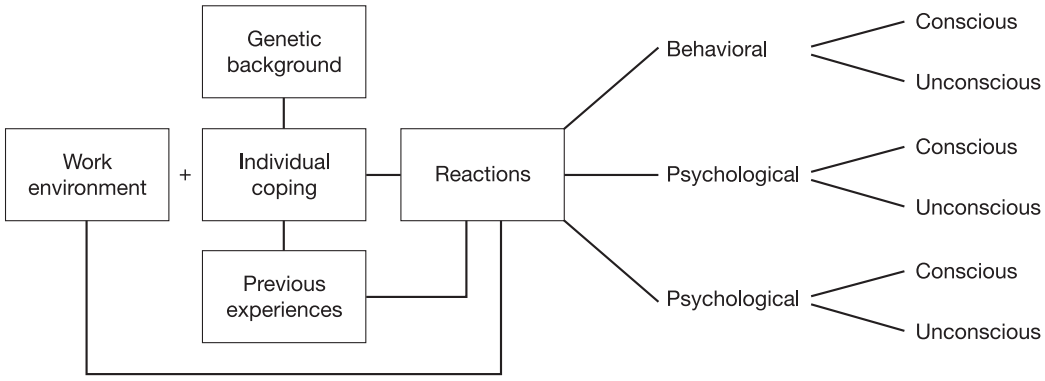
Most people experience, sometime during their lifespan, changes of great importance in their psychosocial situation. Such events or changes clearly defined in time and distinguishable from chronic difficulties and hassles are defined as "life events" in the literature (65-67).

Life events/changes may undoubtedly constitute important potential stressors. The individuals' previous experiences, social support, and individual characteristics are important in the prediction of health consequences of critical life events/changes. Life events/changes play a role in the onset of cardiovascular disorders, mental disorders, fibromyalgia and symptoms from joints and muscles (66-70). The role of life events/changes in the onset of back and neck pain, per se, is not fully understood. A relationship between life events and low back pain has been observed in several studies (71-75), whereas others have not (73, 76-79). Research on life events in relation to neck pain is scarce.

2.4.2 Coping

Stress has been observed to be of importance for the development and course of pain in the back and neck (63, 80). Several aspects are of crucial importance for how people react to psychosocial stress. Psychological and physiological reactions to life changes are according to Theorell grounded in the interplay between individual and environment (66). Figure 2 illustrates that interplay. Genetic factors are important, but also experiences from the past. Social environmental factors have great influence on the individual program that is crucial for the reaction to stressful situations. It has been proposed that this individual program may change somewhat with every new experience over the years (65, 66, 81).

Figure 2. Theoretical model of the interaction between the environment, the individual, and his or her reactions. (From" Handbook of Stress, Medicine, and Health", chapter seven, by Töres Theorell, with permission (66))



The key concept for the individual program is coping. Coping can be looked upon as the pattern of efforts required to manage difficulties and problems that occur in life (81). In the literature, coping style is defined in different ways. One way is in terms of open or covert coping style. Open coping means for example that if you are treated in an unfair way, you directly, or the day after, discuss it with the person that treated you badly. If on the other hand you react with a covert coping style in such a situation, you let it pass without saying anything, you feel bad and perhaps you get into a bad temper at home. According to this definition, the coping behavior is directed towards the aggressor (open) or directed inwards or towards others (covert) (65). Coping is also classified according to the targets (foci) of the strategies used. People with an internal locus of control believe that his/her behavior is guided by his/her personal decisions and efforts, and persons with an external locus of control believe that his/her behavior is guided by external circumstances (82).

Studies have shown that women to a higher degree react with a covert coping style than men (65, 83, 84). The role of open and covert coping style in the onset of back and neck pain has, as far as we know, not been investigated, but a covert coping style has been observed to be of importance for cardiovascular disease and for sick leave patterns (65, 81, 85). It is of special interest to investigate the role of the coping style in concurrent stressful situations.

2.5 TREATMENTS FOR BACK AND NECK PAIN

Treatments of different kind may be of importance for decreasing back and neck pain, in a short or longer perspective. Not long ago, one thought that treatments that "only" decrease pain, like drugs, high frequent TENS and light massage, were of no value, and that it was good to try to withstand the pain and not to "spoil" the body with pain decreasing treatments if they did not correct the cause. Today we know that to reduce the pain is important for several reasons. First, long-lasting severe pain may make the central nervous system more sensitive for pain. Second pain makes us use the body in an incorrect way, and if we try to avoid pain by inactivity even worse pain problems may arise from reduced mobility, increased disability and social isolation (fair avoidance) (86). Third, pain can makes you worried and depressed and that may cause more pain or new pain-related illness (87, 88). There is a long row of more or less accepted treatments for patients with back and neck pain, and few of these are evidence-based.

2.5.1 Advice on staying active

By the time for planning the thesis, the consensus regarding treatment for non-specific back and neck pain consisted of advice and support from the caregiver aiming to empower the patient with the understanding that it is best for recovery to stay active and live as normal a life as possible, including work and physical activities (15, 89-91). These interventions are designed to improve the patients' pain coping strategies and to remove fear and uncertainty and to give the patient the confidence that the back and neck are robust even if they hurt.

To help clinicians to get an overview of the scientific knowledge, and to give advice on how to meet and treat patients with non-specific back and neck pain, evidence-based guidelines are distributed in many countries. In a comparison of 11 different national evidence-based guidelines on back pain, the recommendations in the guidelines were similar regarding the diagnostic classification (diagnostic triage) and the use of diagnostic and therapeutic interventions (92). Consistent recommendations were the early and gradual activation of patients, the discouragement of prescribed bed rest, and the recognition of psychosocial factors as risk factors for chronicity.

Despite efforts, the clinical guidelines have not always had a good impact in primary care. In a cross-sectional study with the aim of surveying how familiar clinicians were with evidence-based guidelines for back pain, 42% of the physicians and 37% of the physiotherapists working in the primary health care in the Örebro County Council, Sweden were unfamiliar with the content of the existing guidelines (93).

2.5.2 Manual therapy

Many patients with back and neck pain get treatment with some kind of manual therapy as spinal manipulation/mobilization and massage. Manual therapy involves a variety of procedures directed at the musculoskeletal structure. Manual therapy is given by several different therapists, and in Sweden the most common are naprapaths, chiropractors and physiotherapists with special education in manual therapy.

2.5.2.1 Massage

Massage for neck pain

In 2006 a review was published about the effectiveness of massage therapy for non-specific neck pain in adults (23). Even though 19 publications were included, no conclusions could be drawn, either because of contradictory results, or because the massage treatment was part of a multimodal program. The summary did establish, however, that massage is a safe treatment method for neck pain, and that possible side effects were incidental and not dangerous. More studies with high scientific quality are needed to enable an assessment of whether massage can be recommended for neck pain.

Massage for low back pain

A review of the effectiveness of massage therapy as the only treatment for non-specific low back pain in adults included nine articles of high scientific quality (94). In conclusion, there was evidence that massage is an effective treatment for non-specific low back pain. More recent articles included in the review showed a good long-lasting effect on prolonged low back pain. A need was seen for studies assessing the effects of massage on acute low back pain, return to work, long-term effects, and cost-effectiveness.

A review from 2003 of effectiveness, safety, and costs for some of the most popular complementary and alternative medical therapies concluded that massage is an effective treatment for prolonged back pain (95). They found small clinical advantages in manipulation treatment, equivalent to those of the other usual treatment forms for sub-acute and prolonged back pain.

Summary

There is strong evidence that massage is an effective treatment for low back pain (94, 95). It has not, however, been possible draw any conclusions on the effect of massage on neck pain because of contradictory results and lack of studies of high quality (23, 96).

2.5.2.2 Spinal manipulation and mobilization

Spinal manipulation has a prominent role in evidence-based national guidelines for treatment of back pain (92). Recommendations in guidelines can vary somewhat from country to country. A number of evidence-based guidelines for neck pain have recommended spinal manipulation, although a minority has not (96).

Evidence for the effectiveness of manipulation and mobilization is often summarized under the same heading, as the indications for using the therapies are usually the same. It is not known if manipulation and mobilization are equally effective treatment methods, but Hurwitz et al. found that manipulation and mobilization gave comparable clinical effects for neck pain (97). In a subsequent publication using the same material, an increased risk of neck pain, stiffness, and headache within 24 hours was reported among the neck patients that received manipulation as compared to those who received mobilization (98).

Manipulation/ mobilization for neck pain

In 2000 a Swedish review was issued in which high-quality scientific articles on back and neck pain were summarized (15, 99). Spinal manipulation and mobilization were considered important and effective in the review. Limited evidence was found for the effectiveness of manual treatment (mobilization, manipulation, and massage) for acute and prolonged neck pain when it is given separately. The evidence was strong for manipulation not being more effective that physiotherapy treatments, and there was moderate evidence for manipulation not being an effective treatment for prolonged neck pain.

A review from 2004 on the effectiveness of spinal manipulation/mobilization on non-specific neck pain included 33 articles (100). In conclusion, there was strong evidence that persons with neck pain (with or without headache since at least a month) who received multimodal treatment had better pain relief and better abilities to participate in daily activities than did persons who had not received any treatment. The multimodal treatment included physical exercises as well as spinal mobilization/ manipulation. It was unclear whether manipulation or mobilization was preferable, but when the techniques were compared they were equally effective.

Another review with 43 articles was published in 2004 with the aim of an evaluation of the effectiveness of spinal manipulation/mobilization of the spine in treatment of low back pain and neck pain (101). Regarding acute neck pain, so few studies had been published that it was impossible to draw any conclusions on the effectiveness of manipulation/mobilization. Regarding prolonged neck pain, there was moderate evidence that manipulation/mobilization were more effective than care by a general practitioner for pain in the short term, and that manipulation reduces pain as effectively as high-tech rehabilitation training in both the short and long terms. The conclusion was that manipulation and/or mobilization can be recommended with a certain measure of confidence for low back and neck pain.

Manipulation/ mobilization for low back pain

The Swedish report published in 2000 found moderate evidence that manipulation is more effective than placebo for short-term pain relief in acute low back pain (15). The risks with spinal manipulation were assessed in the report as being small, providing that the patients are carefully chosen and correctly diagnosed, and that the treatment is given by a trained therapist. In the summary, it is recommended that spinal manipulation should be considered for low back pain within the first six weeks for patients who need pain relief and who cannot return to their normal activities.

Regarding manipulation for prolonged low back pain, the report establishes that there is strong evidence that manipulation gives better short-term pain relief than a placebo treatment (15). There is moderate evidence that manipulation gives better short-term pain relief than does normal treatment by a general practitioner, bed rest, analgesics, or massage.

A review was published in 2003 with the purpose of sorting out the contradictory results related to the use of spinal manipulation (12). Thirty-nine articles of high quality were identified, and meta-analyses were carried out. Spinal manipulation was

found to be just as effective as standard treatment for low back pain, and more effective than placebo.

In a more recent published review on manipulation and low back pain it was concluded that manipulation treatment is somewhat better than placebo, no treatment at all, massage, and short wave therapy for non-specific sub-acute low back pain (102). A review from 2004, focused on re-evaluating the effectiveness of manipulation/mobilization for low back pain and neck pain, included 43 articles of high quality (101). The conclusion was that spinal manipulation/mobilization can be recommended with a certain amount of confidence as a practicable alternative for low back pain and neck pain.

Summary

The evidence that spinal mobilization/manipulation is an effective treatment for back and neck pain has long been convincing, although the knowledge situation has become a bit less certain over time. In the Swedish report from 2000, the evidence was considered to be strong that manipulation/mobilization was an effective treatment, especially for pain in the low back (15). In a more recent review, it was concluded that manipulation/mobilization were just as effective as standard treatment (12). In the latest review, from 2004, the authors stated that manipulation/ mobilization could be recommended for low back and neck pain (101). There is still uncertainty about the effectiveness of spinal manipulation/mobilization for acute neck pain, simply because not enough studies have been done in this area.

Table 1. Table of reviews of the effect of massage, spinal manipulation (SMT) and spinal mobilization (MOB). Abbreviations used in the table: LBP: low back pain, BP: back pain, MND: mechanical neck disorders, SMT: spinal manipulative therapy, MOB: spinal mobilization therapy, +: The treatment has effect, -: the treatment has not effect, ?: the effect of the treatment is unknown.

1a. **MASSAGE**

Author	Number of included studies	Disorder	Conclusion about effectiveness	Evi-dence
Brosseau, (103)	2	Tendinitis pain	No conclusions can be drawn concerning the use or non-use of deep transverse friction massage for the treatment of tendinitis pain as iliotibial band friction syndrome and extensor carpi radialis tendonitis.	?
Furland, (94)	9	LBP	Massage might be beneficial for patients with sub-acute and chronic non-specific LBP, especially when combined with exercises and education.	+
Cherkin, (95)	3	BP	Initial studies have found massage to be effective for persistent back pain. Preliminary evidence suggests that massage may reduce the costs of care after an initial course of therapy.	+
Haraldsson, (23)	19	MND	No recommendations for practice can be made at this time because the effectiveness of massage for neck pain remains uncertain.	?

1b. **MANIPULATION (SMT) and MOBILIZATION (MOB)**

Author	Number of included studies	Disorder	Conclusion about effectiveness	Evi-dence
Nachemson, (15)	16	Acute and sub-acute LBP	There is moderate evidence that SMT/MOB is more effective than a placebo treatment for short-term pain relief of acute LBP. Because of inconsistent findings, it is not possible to judge whether SMT/MOB is more effective than other physical therapeutic applications (massage, short-wave diathermy, exercises) or drug therapy for acute LBP.	+
	9	Chronic LBP	There is strong evidence that that SMT/MOB provides more effective short-term pain relief than placebo. There is moderate evidence that SMT/MOB is more effective than usual care by the general practitioner, bed rest, analgesics, and massage for short-term pain relief. There is limited and conflicting evidence of any long-term effects.	+
	3	Acute and sub-acute NP	The evidence about the effect of manual therapy (SMT, MOB, massage) when used alone and when compared with other treatments is insufficient.	?
	3	Chronic NP	Strong evidence indicates that SMT/MOB is not more effective than physical therapy, and moderate evidence indicates that SMT/MOB is not an effective treatment for chronic non-specific NP.	-
Assendelft, (12)	39	LBP	There is no evidence that spinal manipulative therapy (SMT) is superior to other standard treatments for patients with acute or chronic low back pain.	+
Cherkin, (95)	26	BP	Spinal manipulation has small clinical benefits, equivalent to those of other commonly used therapies.	+
Ferreira, (102)	34	LBP	SMT produces slightly better outcomes than placebo therapy, no treatment, massage, and short wave therapy for non-specific LBP of less than 3 months' duration. SMT, exercise, usual physiotherapy, and medical care appear to produce similar outcomes in the first 4 weeks of treatment.	+
Bronfort, (101)	43	LBP NP	Our data synthesis suggests that recommendations can be made with some confidence regarding the use of SMT and/or MOB as a viable option for the treatment of both low back pain and NP.	+
Gross, (104)	33	MND	Multi-modal care has short-term and long-term maintained benefits for sub-acute/chronic MND with or without headache. Common elements in this care strategy were mobilization and/or manipulation plus exercise. The evidence did not favor manipulation and/or mobilization done alone or in combination with various other physical medicine agents; when compared to one another, neither was superior.	+

2.5.3 Naprapahty

Naprapaths constitutes the largest profession within the field of specialized manual medicine in Sweden as well as in Finland and in Norway. The naprapathic profession is since 1994 a part of the Swedish health and medical care system, by the license from the National Board of Health and Welfare, for treating patients with musculoskeletal pain and pain-related disability. Over 900 licensed naprapaths carry out approximately 1.5 million naprapathic treatments each year in Sweden (9 million citizens). Naprapaths in Sweden have a four-year full-time education with an addition year within the licensed health care system.

Naprapaths are soft and connective tissue specialists and naprapathy in Scandinavia is defined as a system for specific examination, diagnostics, manual treatment and rehabilitation of shortened or pathologic soft and connective tissue resulting in pain and dysfunction in the musculoskeletal system. Naprapathic treatment is called Soft and Connective Tissue Manipulations (SCTM), which is a combination of techniques as spinal manipulation/mobilization, stretching and massage, to treating the shortened tissues in order to increase function and to decrease pain and disability.

Among the diagnoses that is treated by a naprapath are, pain in back and neck and other joints, headache, shoulder pain, radiating pain in upper or lower extremities, and athletic injuries. Naprapaths also work with rehabilitation, health promotion and ergonomic interventions.

The history of naprapathy started in 1907 in the USA, where Dr. Oakley Smith (1880-1967), a trained chiropractor, founded the first school of naprapathy (105). By setting up hypotheses about how the spinal column functions, and what effects were obtained with the manipulation he practiced as a chiropractor, Smith rejected the chiropractic and osteopathic theory; that vertebrae could be subluxated (partially dislocated) as the basis of disease. Instead, the soft and connective tissue was believed to be the cause.

Oakley Smith (1880-1967)

Smiths research in the field of manual medicine is carefully described in his document published in the early 20th century (105-110). He published in 1906 in collaboration with M. C. Paxton and S. M. Langworthy, what has been called the first textbook in chiropractic medicine, titled Modernized Chiropractic (106). In this book a theory of the center of motion of the vertebral unit was described for the first time together with motions like flexion, extension, rotation and lateral flexion in the spine (111). In "The Connective Tissue Monograph," and in later published publications, Smith develop his ideas and knowledge of the connective tissue cause of disease and the treatment hereof of that now (since 1907) was called Naprapathy (105, 107). His early thoughts and research in the manual medicine field has been acknowledged by several researchers in the field today (111-113).

In 1970 the Swede Björn J:son Berg, a student of Smith in Chicago, started an education center for naprapathy in Stockholm, Sweden (the Scandinavian College of Naprapathic Manual Medicine; Naprapathögskolan) where also students from Norway and Finland is educated. This Scandinavian education in naprapathy gives a broader education in manual techniques, than did the American education. Finland also has an education in naprapathy within The University of Kotka, since 2002.

The role of the connective tissues in pain conditions stated by Smith has been confirmed later by others. Videman asserts that changes in the connective tissue occur in situations that lead to immobilization, and that these changes are important to try to avoid or to treat with passive or active movements in order to prevent or treat pain and pain-related disability in the musculoskeletal system (114). Videman states the hypothesis that immobilization, for any reason, initiates a pathogenetic chain of musculoskeletal degenerations.

Langevin and Sherman present "a new, testable pathophysiological model integrating connective tissue plasticity mechanisms with several well-developed areas of research on long lasting low back pain (pain psychology, postural control, neuroplasticity)," where they hypothesize that pain-related fear leads to a cycle of decreased movement, connective tissue remodeling, inflammation, nervous system sensitization and further decreased mobility (115). They hypothesize that plasticity in both connective tissue and nervous systems, linked to each other via changes in motor behavior, play a key role in the natural history of long lasting low back pain, as well as in the response of long lasting low back pain to treatments and placebos. The authors mean that these will potentially illuminate the mechanisms of a variety of treatments that may reverse these abnormalities by applying mechanical forces to soft tissues, by changing specific movement patterns or more generally by increasing activity levels. According to Langevin et al., the integrative mechanistic model incorporating behavioral and structural aspects of long lasting low back pain will strengthen the rationale for a multidisciplinary treatment approach, including direct mechanical tissue stimulation, movement reduction, psychosocial intervention and pharmacological treatment to address this common and debilitating condition.

Panjabi presented in 2006 what he called "A new hypothesis, based upon the concept that subfailure injuries of ligaments (spinal ligaments, disc annulus and facet capsules) may cause long lasting back pain due to muscle control dysfunction" (116). The hypothesis has the following steps: single trauma or cumulative micro-trauma causes sub-failure injuries of the ligaments and embedded mechanoreceptors. This results in abnormal stresses and strains in the ligaments, mechanoreceptors and muscles, and excessive loading of the facet joints. Due to inherently poor healing of

spinal ligaments, accelerated degeneration of disc and facet joints may occur. The abnormal conditions may persist, and, over time, may lead to long lasting back pain via inflammation of neural tissues. The article by Panjabi was commented on by Schleip et al., meaning that in addition to the structures mentioned by Panjabi, one should add fascia, and especially the thoracolumbal fascia (117). They present evidence that the thoracolumbal fascia is significantly involved in all three levels of the hypothesis of Panjabi concerning spinal ligamentous structures: the transducer function of the tissues, their structural spinal function, and their proneness for failure injuries.

The ideas of Schleip, Panjabi, Langevin and Sherman support the naprapathic ideas of the origin of pain and pain-related disability originally stated by Smith in the beginning of 20th century.

3 AIMS OF THE THESIS

The general aim of this thesis was to deepen the knowledge about some risk factors for back and neck pain, and to evaluate the effect of naprapathic manual treatment for non-specific back and neck pain.

3.1 SPECIFIC AIMS

- To expand the knowledge about the occurrence of life events and how they affect the risk of low back and neck/shoulder pain, and to investigate the role of the number of life events and critical life changes; the role of the arena on which the event took place; and the role of time that has passed since the event took place for the risk of low back and neck/shoulder pain, respectively.

- To explore the influence of a covert coping style on the onset of low back and neck/shoulder pain. For this purpose the following research questions were addressed: Is there a relationship between a covert coping style and the onset of low back and neck/shoulder pain, and does stress in the form of critical life changes have an influence on such a relationship? Are there gender differences in the prevalence of a covert coping style, as well as in the strength of potential associations with low back and neck/shoulder pain?

- To investigate the associations between smoking and alcohol consumption respectively and long-term sick leave due to back or neck pain.

- To compare the effectiveness of naprapathic manual therapy to the effectivness of evidence-based care defined as support and advice on staying active and on pain coping strategies, provided by a physician, for patients with non-specific pain in the back and/or neck lasting for at least two weeks. The intention was not to evaluate the different components in the treatments separately, but to compare the treatments in a pragmatic way, standardized as far as possible, the way they usually are carried out in outpatient clinics.

4 MATERIALS AND METHODS

4.1 MATERIAL IN STUDIES I AND II

The MUSIC-Norrtälje Study
Studies I and II are sub-studies within the MUSIC-Norrtälje Study: a population-based case-control study on determinants and consequences of low back and neck/shoulder disorders. The study base (about 17,000 persons) comprised all men and women 20-59-years-old, living in and not working outside the municipality of Norrtälje, Sweden, during the study period November 1993 to November 1997.

A case was defined as a subject from the study base who sought care or treatment for a new episode of low back pain or neck/shoulder pain. Patients with trauma in the anamnesis and/or with a by a doctor diagnosed rheumatic disease as rheumatoid arthritis and Mb Bechterew were excluded. Among the neck/shoulder pain patients were those with pain in neck/upper thoracic spine (with or without radiating or referred pain in the arms and headache) as well as shoulder pain patients. Among the low back pain patients were those with pain in the lower back, with or without radiating or referred pain in the legs and/or in the buttocks. A "new episode" meant not having sought care for these problems during the preceding six months. Cases were identified by any of the 75 known caregivers in the municipality. None of the invited caregivers refused to participate. The caregivers were physicians, naprapaths, chiropractors and physiotherapists as well as alternative caregivers such as osteopaths, massage therapists and homeopaths. The caregivers were asked to contact the MUSIC-secretariat when they met a suitable case. The secretariat then contacted the case as soon as possible for an appointment (that took place within two months, most commonly within one to two weeks).

Controls were selected as a stratified random sample from the study base, with considerations taken for sex and age (in five-year intervals), by means of the population register, which was continuously updated. One control that not had sought care for low back or neck/shoulder pain during the preceding six months was chosen for each case. If a selected control was unable or refused to enter the study, he or she was not replaced. If there was space in the investigation schedule, another control within the same five-year span as the last control was chosen. The proportion of selected controls that participated in the study was about 70% (1,700).

In all, 709 cases with low back pain, 352 with neck/shoulder pain and 87 with low back and neck/shoulder pain were included.

At the MUSIC-secretariat, all subjects filled out extensive self-administered questionnaires, underwent a clinical examination and were interviewed about individual and environmental factors considered to be potential risk factors for low back and/or neck/shoulder pain.

The MUSIC-Norrtälje Study was approved by the Ethics Committee at the Karolinska Institutet, Stockholm, Sweden (Diary No. 93-255) and was founded by grant from the Swedish Council for Work and Life Research and the Stockholm County Council.

4.2 METHODS IN STUDY I

4.2.1 Assessments and classification of exposure

In life events research, different methods for exposure assessment have been used. One method was developed by Holmes and Rahe, the Social Readjustment Rating Scale (SRRS). It has the underpinning idea, based on Selye's stress theory, that a non-specific accumulation of life changes, regardless of whether they are positive or negative, during a short period of time, would increase vulnerability to illness. The required adaptation is an important component in the illness etiology, via the sympatho-adreno-cortical systems, according to this theory (66, 118).

Brown and Harris developed the Life Events and Difficulties Schedule (LEDS), a semi-structured interview form, designed to assess the impact of events from a sociological point of view (67). The extensive interview was designed to determine whether the event was a chronic difficulty or a life change and whether it was markedly threatening or not.

In the MUSIC-Norrtälje Study, an interview technique measuring several aspects of life events, including "critical life changes" based on the theories of Holmes and Rahe, as well as Brown and Harris, was used. A "critical life change" is in the thesis defined as a life event that brings about a marked psychological or psychosocial change for the study subject. The interview about psychological and psychosocial factors was performed by one of seven behavioral scientists and lasted for about one hour for each study subject. The interviewers did not know whether they interviewed a case or a control subject. Regular group meetings were held to keep inter-rater reliability constant over time (119).

The interview technique, measuring several aspects of life events including "critical life changes", was based on a previously validated questionnaire by Theorell et al. (83). The two main questions in the interview were: "*Looking back five years, have there been any life events or changes in your work or workplace during that period?"* and *"Looking back five years, have there been any life events or changes concerning your life outside work during that period?"* The questions were open and the study subject was asked to specify the life events and to tell when they took place.

Life events that brought about a psychological or psychosocial lasting change for the study subject, as lasting changes in social relations, in household participation, in family relations, in support at work or in use of skills, were classified as "critical life changes". The two most outstanding changes within the two arenas "at work" and "outside work", respectively, were noted. The classification of critical life changes was the result of a discussion between the study subject and the interviewer.

4.2.2 Comparisons and statistical analysis

In the analysis, subjects classified into different categories regarding reported life events/critical life changes ("exposed") were compared to a reference category ("unexposed"). When analyzing life events the reference category was made up of subjects who had experienced no or one life event the preceding five years. When analyzing critical life changes on different "arenas", the reference category was made up of subjects with no critical life changes.

Exposed subjects were compared to unexposed subjects regarding the risk of low back and neck/shoulder pain, respectively, by calculating an odds ratio with 95% confidence interval by means of logistic regression analysis. Odds ratios were adjusted for age (dichotomized in <45 and ≥45-years-old) and sex. An additional number of factors that had turned out to be related to the outcomes in previous reports from the MUSIC-Norrtälje Study were considered with regard to their potential confounding effect in the analyses (120-122). The potential confounders were introduced in the model, one at a time, and the amount of change in the coefficient of the exposure term was examined. If it changed considerably (around 10% or more), the variable was considered a confounder and added to the model (123). None of these factors turned out to be confounders, and were thus not included in the final regression model. The estimated odds ratios can be interpreted as relative risks as the study was population-based and the controls were a random sample from the study base (124).

In addition, we investigated potential effect modification by time spans and arenas, respectively, by means of stratified analysis. Thus, the relationship between number of life events and the outcomes, were calculated for different time spans concerning when during the preceding five years the event took place. Similarly, odds ratios associated with number of life events were calculated for different arenas, i.e., whether the event took place outside work or at work.

In the analyses, cases with concurrent pain in the neck/shoulder and low back (n=87) were treated both as neck/shoulder pain cases as well as low back pain cases.

All calculations were performed in the statistical program Intercooled STATA 8.0.

4.3 METHODS IN STUDY II

Since Study II is published as a "Letter to the Editor", there is additional information in this text as compared to the published study.

4.3.1 Assessment and classification of exposure

The most common way to measure open or covert coping style is by questionnaire, and several published studies have used a Swedish version of a questionnaire originally developed for a study on high blood pressure (125, 126). The basic structure of this Swedish version from 1973, has been modified and adapted to Swedish work conditions in connection with the MUSIC-Stockholm Study, a previous study carried out within the MUSIC network (83). The self-administrated coping questionnaire is presented in Table 2. It has an opening question which deals with the general question about what the subject would do if he/she would be faced with unfair treatment at work. Different answer alternatives are given. For each alternative, the subject may fill out on a four-point scale as to whether this alternative applies, from "never" to "mostly". In agreement with an earlier performed factor analysis, the items were reduced to two: one describing an open and one describing a covert coping style (65, 79). A typical answer indicating an open coping style is: "I protest directly." or "I speak to the person later when things have calmed down." (yes, mostly or sometimes). The opposite, a covert coping style, is exemplified by the statements: "I walk away." (yes, mostly or sometimes) and "I get into a bad temper at home." (yes, mostly or sometimes).

Table 2. Questions of coping style used in Study II.

We want you to think about a situation at work that most people experience sometimes. Try to separate your reactions depending on with whom the problem occurs:
A) a superior, B) a workmate or C) a customer/patient etc.

All questions shall be answered for A, B and C, by choosing one of the four alternatives:

1. Yes, mostly
2. Yes, sometimes
3. No, seldom
4. No, never

1. How do you usually react when you are treated in an unfair way or get into a conflict with (A) a superior, (B) a workmate or (C) a customer/patient?

a. You let it pass without saying anything
b. You walk away
c. You protest directly
d. You talk to the person right away
e. You yell at the person right away

2. What happens then?

a. You speak to the person later when things have calmed down
b. You feel bad (headache, stomach ache etc.)
c. You get into a bad temper at home

According to factor analysis, items 1a, 1b, 2b and 2c constitute one factor (covert coping style) and 1c, 1d, 1e and 2a a second factor (open coping style).

In items measuring covert coping, the four-point scale had the highest values when the answer was "yes, mostly" and lowest values when the answer was "no, never." In items measuring open coping, it was the other way around. To get a measure of each study subjects' coping style, a mean value was calculated for the relevant situations with a superior, a workmate and/or a customer/patient, and finally, a mean value for all eight items was calculated, where high values represent a covert coping style and low values an open coping style.

The internal dropout in the coping strategy measurements was 11% among cases and 11% among controls, probably mainly dependent on the fact that these subjects had not experienced such a situation.

In the analysis of different coping style, the subjects' coping mean value was classified into quartiles according the distribution among the controls, men and women taken together. Belonging to the fourth quartile of the distribution was defined as having a covert coping style. Belonging to the first quartile of the distribution was defined as having an open coping style.

4.3.2 Comparisons and statistical analysis

Since gender differences concerning coping style were expected, analyses were made separately for men and women. Differences in the proportion of a covert coping style among men and women were analyzed using χ^2 test.

Exposed subjects were compared with unexposed subjects regarding the risk of low back pain and neck/shoulder pain, respectively, by calculating an odds ratio (OR) with 95% confidence interval (CI) by means of logistic regression analysis. Odds ratios were adjusted for age (dichotomized in < 45 and ≥ 45-years-old) earlier episodes of neck/shoulder and low back pain lasting for at least seven days (dichotomized in never/once and more than once), and socio-economic status (dichotomized in blue-collar workers/white-collar workers). An additional number of factors that had turned out to be related to low back and neck shoulder pain in previous reports from the same study were considered with regard to their potential confounding effects in the analyses (120, 121, 127). The statistical methods for investigation potential confounding, and the factors tested are presented in the chapter 4.2.2 above.

A potential interaction between a covert coping style and stress in form of critical life changes was evaluated using departure from additivity of effects as a criterion of interaction, as suggested by Rothman and colleagues (128). Interaction between the two factors critical life changes (<2/≥3 critical life changes the preceding five years) and a covert coping style (first quartile/fourth quartile) was calculated. To quantify the amount of interaction the attributable proportion due to interaction (AP) was calculated together with a 95% CI (129). The AP, which take a value between 0 and 1, is the proportion of the incidence among persons exposed to two interacting factors that is attributable to the interaction *per se* (i.e. reflecting their joint effect beyond the sum of their independent effects).

In the analysis, cases with concurrent pain in the neck/shoulder and low back were treated both as neck/shoulder pain cases as well as low back pain cases (n=87).

All calculations were performed in the statistical program Intercooled STATA 8.0.

4.4 MATERIAL AND METHODS IN STUDY III

Study III is based upon the longitudinal study "Hållbar Arbetshälsa i Kommuner och Landsting" (Work and health in the public sector in Sweden) the HAKuL-Study, that started in 1999 and ended in 2004 in four county councils and in local authorities in six municipalities, located all over Sweden.

The overall aim of the HAKuL-Study was to strengthen sustainable health for working and wellbeing among employees in the public sector in Sweden, as well as to implement and support early rehabilitation for those with impaired work ability.

In total about 9,000 employees, not sick listed more than three months in a row at baseline, were asked to participate. The main occupational groups in the study population were registered nurses, assistant nurses, home-based personal care workers in elderly care, employees at child care centers, administrative personnel, and teachers, and 81% were women. The included employees were followed for three years by means of questionnaires and sick leave data. The inclusion process and the progress of study persons through study are described in Figure 3.

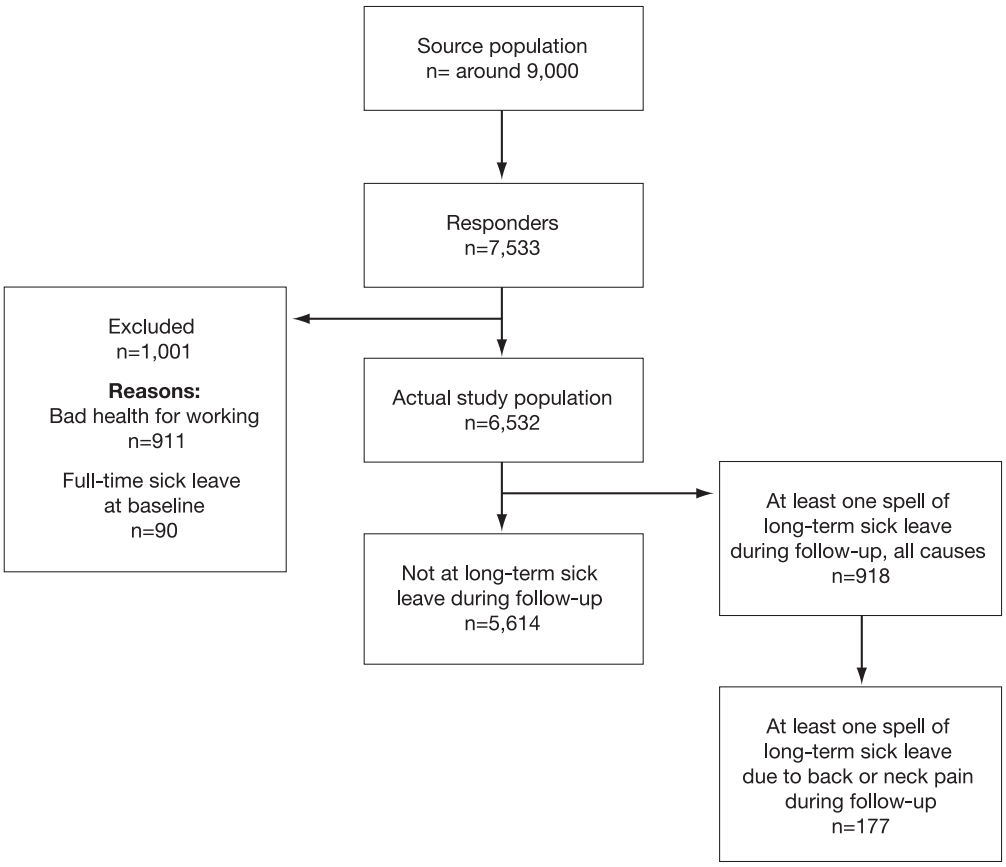
In this study, patients with long-term sick leave due to back and/or neck pain were studied. Among those patients were all kind of back and neck pain with or without

headache and/or radiating pain in the extremities, with the exception of rheumatic disease as rheumatoid arthritis and Mb Bechterew. Patients on long-term sick leave due to only pain in the shoulder were not included.

The participating organizations were not randomly but strategically chosen in collaboration with the national and local employer organizations and unions in order to cover different parts of the country as well as different fields of activities in the public sector. The procedure was necessary in recruiting organizations with long-standing commitment to the study as the included organizations had to help out with in several parts of the study, as administrations of the questionnaires, report employees on long-term sick leave to the research group and start intervention activities after having received feedback from the three waves of reviews.

The HAKuL-Study was approved by the Ethics Committee at Karolinska Institutet, Stockholm, Sweden (Diary No. 99-242), and was founded by grant from AFA Labour Market Insurances.

Figure 3. Flow chart describing the inclusion process and the progress of study persons through Study III.



4.4.1 Assessments and classification of cases and exposure

The study started with an extensive baseline questionnaire including questions on social situation, health, lifestyle, and work factors. The questions on alcohol and smoking used for this study are displayed in Table 3. The alcohol questions are derived from the AUDIT-questionnaire (130). The lifestyle part of the questionnaire also comprised questions on physical exercise habits, and weight and height.

Table 3. Questions about alcohol consumption and smoking in the baseline questionnaire, and the distribution of the answers in the cohort in Study III.

Questions	**Proportion**
How often do you drink alcohol?	
Never	8%
Once per month or less often	33%
2-4 times per month	46%
2-3 times per week	12%
4 times per week or more often	1%
(99% of the responding study persons answered this question)	
How many "drinks"* do you take on a typical day when you drink alcohol?	
1-2	60%
3-4	31%
5-6	7%
7-9	2%
10 or more	0%
(92% of the responding study persons answered this question)	
Do you smoke?	
Yes, I am a daily smoker	19%
Yes, I smoke sometimes	7%
No, I have stopped smoking during the last year	2%
No, I have not smoked during the last year	24%
No, I have never been a smoker	48%
(98% of the responding study persons answered this question)	
If yes, how many cigarettes per day on average?	
1-2	12%
3-9	24%
10-20	62%
>20	2%
(96% of the responding study persons that were current smokers answered this question)	
If yes, how many years have you been smoking in total?	
0-5	8%
6-10	12%
11-20	30%
21-30	33%
>30	17%
(98% of the responding study persons that were current smokers answered this question)	

* Examples of "drinks": one bottle of medium strong beer, 1/2 bottle of strong beer, one glass of wine, one small glass of dessert wine, 4-6 centiliters of spirits.

In this study the term long-term sick leave was used to describe a continuous absenteeism from work due to pain in the back or neck for ≥28 days in a row. All new spells of long-term sick leave periods were consecutively reported from the employer or the occupational health service during a period of three years from baseline.

During the three-year follow-up 177 persons had at least one spell of continuous sick leave due to back or neck pain for 28 days or more.

With regard to smoking habits, subjects were classified into never smokers (people who reported that they never had smoked), ever smokers (daily smokers, those who sometimes smoke and those who have stopped smoking), ex-smokers (those who have stopped smoking) and current smokers. For current smokers, the amount of smoking was calculated and expressed as pack years. One pack year was regarded as the equivalent of for example 20 cigarettes smoked per day for one year or 10 cigarettes smoked per day for two years, etc. With regard to alcohol drinking, subjects were classified into different categories according to reported frequency and amount of alcohol drinking.

To be included in the study, a participant was requires to have "good health for working" as defined by using a previous developed index (60), based on a combination of answers to questions on general health from the SF-36 health survey (131) and the answer to a question from the WAI Questionnaire (132). Those with bad general health (a score less than 65 on the SF-36 general health scale) and who on the WAI Questionnaire reported it to be "unlikely" or "not certain" that they could continue their work for another two years, with regard to perceived health status, were classified as having "bad health for working." These were excluded from the analyses (n=911) and so were those who were on full-time sick leave due to any reason the day they answered the questionnaire (n=90).

4.4.2 Comparisons and statistical analysis

In the analysis different categories of smokers were compared with never smokers, and different categories of alcohol drinkers were compared with subjects reporting low alcohol consumption. Hazard ratios (denoted as rate ratios (RR)) regarding risk of a first spell of long-term sick leave due to back or neck pain associated with smoking or alcohol consumption respectively were calculated by means of Cox proportional hazard regression model together with 95% confidence intervals (CI). Person time was calculated from inclusion to the day of the first sick leave period of $\geq$ 28 days for any reason, to the day of quitting the job, or to the end of follow-up, whichever occurred first. The exact quitting day was known for 25 percent of those quitting their job. Those with unknown quitting date, and those leaving the job between baseline and 18-month follow-up were given nine months of person time and those leaving the job between 18 and 36 months follow-up were given 27 months of person time. Potential confounding factors assessed at baseline were introduced in the model, one at a time, and the amount of change in the coefficient of the exposure term was examined. If it changed around 10% or more, the factor was considered a confounder and added to the regression model (123). Hazard ratios for smoking or alcohol consumption (in the same regression model) were adjusted for the following confounding factors: pain (much or very much pain/not much pain), socio-economic class (stratified into three skill levels, occupations require at least 3-4 years education after high school, skilled workers with vocational education and unskilled workers), and age (continuous). In addition several factors were considered with regard to potential confounding but none of these confounded the relation between alcohol and smoking respectively and sick leave; thus they were not included in the final model.

Assumption of proportional hazards for the exposures and confounding factors were examined by the method of Shoenfeldt's partial residuals; there was no indication of

violation of the assumption for any of the variables included in the regression models (133). Trend test for a dose response relationship was performed by using the exposure classified in four categories in a logistic regression model (134). Correlation between smoking and alcohol consumption was assessed with Spearman's rank correlation coefficient.

4.5 MATERIAL AND METHODS IN STUDY IV

Study IV in this thesis is based upon the pragmatic randomized controlled trial, called "the Swedish BJÖRN-Trial", which was performed in Stockholm, Sweden in March 2005 to October 2006.

The trial was approved by the Ethics Committee of the Karolinska Institutet (Diary No. 03-657) and registered in the public registry called Current Controlled Trials (ISRCTN56954776). It was financially supported by the Swedish Research Council, the Stockholm County Council, the Uppsala County Council, Capio, and the Swedish Naprapathic Association.

4.5.1 Setting and participants

Participants were recruited by advertising mainly among employees at two big public companies (about 40,000, mainly women in the healthcare sector, the schools and in the postal service) in Stockholm, Sweden from March to September 2005. Potential participants were asked to contact the study administration if they fulfilled the inclusion criteria, which was present pain in back and neck of the kind that brought about marked dysfunction at work and/or in leisure time, for at least two weeks.

The study administrator informed the participants and made the first step exclusions (symptoms too mild, pregnancy, specific diagnoses such as acute slipped disc or spinal stenos, inability to understand Swedish, visits to a naprapath in the preceding two months or another manual therapist in the preceding month with the exception of massage). Subjects fulfilling the criteria for participation were then asked to visit the study center.

At the study center, patients gave their informed consent and answered an extensive self-administered questionnaire. After that an experienced physician (one of four) performed a medical examination (about 20 minutes) using a standardized form, made a diagnosis, and prescribed medication if necessary. Further exclusions were made based on the following exclusion criteria: too mild symptoms (the physicians' *subjective* opinion based on the estimated pain and disability in the questionnaires filled in before the examination, and the results of the anamnesis and physical examination), evidence-based advice during the past month, surgery in the painful area, acute prolapsed disc, spondylolisthesis, stenosis or "red flags" (15).

Patients with pain in neck/shoulder, upper thoracic spine and/or pain around the scapulae with and without radiating pain in the arms and/or headache were included and called neck pain patients. Patients with only pain in the shoulder joint were not included. Among the included that are called back pain patients were those with pain in the lower thoracic spine, lumbar spine with or without radiating pain in the legs and/or in the buttocks. Patients with specific diagnosis as herniated discs, spinal stenosis and patients with so called "red flags" (15) were not included.

4.5.2 Randomization and interventions

Included patients were assigned to two groups by randomization and no pre-stratification or blocking was used. An assistant not involved in the project prepared 500 opaque, sequentially numbered sealed envelops with cards numbered 1 or 2 (randomized by a computer), indicating the two interventions. Patients were sequentially numbered in the order they came to the study center and received the assignment envelope with the corresponding number. The unmasking was performed by the physician after the medical examination, so that the assistant, the physician and the patient were all blind to the group assignment until after all patient baseline data was collected.

The treatments in both groups were conformed to the patients' condition, but standardized as far as possible concerning for example the length of treatment sessions and how to perform them in different situations, by several group meetings held in advance with the physicians and the naprapaths. The naprapaths were told only to use techniques they had learned at the education centre in Sweden. The content in the evidence-based advice and support were carefully discussed in groups with the physicians in order to make the care reliable.

4.5.2.1 Naprapathic Manual Therapy (Index Group)

For patients randomized to the Index Group, one of eight participating experienced licensed naprapaths was contacted for an appointment within a week. The choice of the naprapath was pragmatic, based on time schedule and location. A maximum of six treatments were given within six weeks in the naprapath's own clinic and a combination of naprapathic manual techniques (such as spinal manipulation/ mobilization, massage, and stretching) was given adapted to the patient's condition. Preventive and rehabilitating advices on physical activity and ergonomics were often given. Each appointment lasted for about 45 minutes, and precise notes were kept about the treatment, the progress, and any adverse reactions.

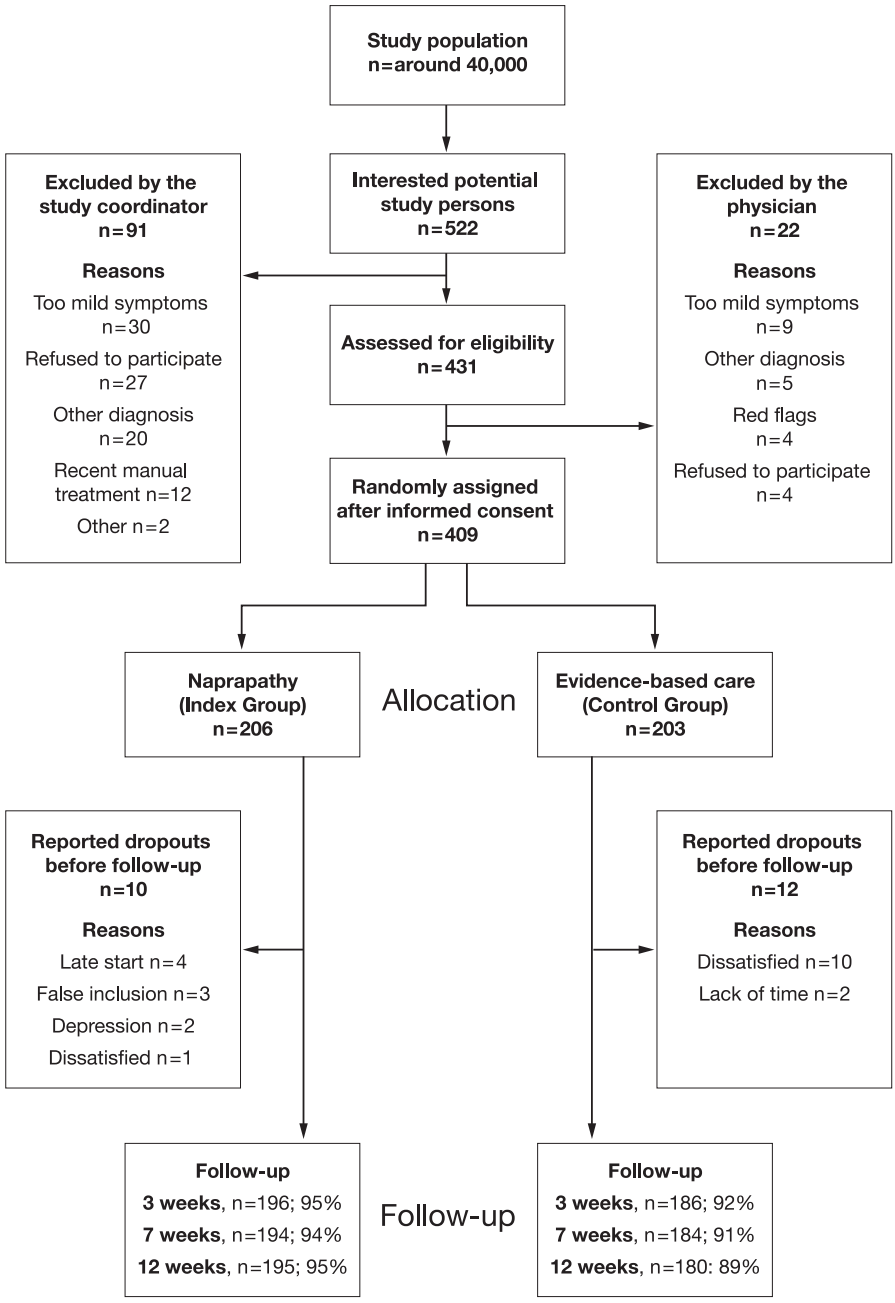
4.5.2.2 Evidence-Based Care Provided by a Physician (Control Group)

Evidence-based care is in this study defined as support and advice on staying active and on pain coping strategies including locus of control, according to guidelines and evidence-based reviews (15, 89-91, 135). The evidence-based care was given in direct conjunction with the medical examination (an additional 15 minutes). The care involved advice and support according to the best scientific evidence available, aiming to empower the patient with an understanding of the importance of staying active and living as normal a life as possible, including work and physical activities. The care also aimed to improve the pain coping strategies. Advice on exercises was general and adapted to the patient's condition. A booklet with examples of exercises and general information on back and neck pain was provided. Precise notes were kept and a second consultation (about 15 minutes) was scheduled after three weeks. Additional consultation could be offered if necessary.

4.5.3 Outcomes and follow-up

All outcomes in the trial were self-rated by web-based (61%) or postal questionnaires five times during the year following the inclusion. Starting from the day of inclusion, data from 3-, 7- and 12-week follow-ups are included in Study IV. Figure 4 describes the progress of subjects through the trial.

Figure 4. Flow chart describing the progress of subjects through the trial in Study IV.



4.5.3.1 Primary Outcomes

The primary outcomes pain and disability were measured by a slightly modified Chronic Pain Questionnaire (CPQ) originally developed by von Korff, with six items with a numerical 11-point scale and one item on the number of disability days (136-139). In the current trial we changed the questions to concern the past four weeks instead of the past six months. Three items rated pain and three items rated disability. A pain score and a disability score were constructed from the mean of these items. Disability was also measured in a more detailed way by a modified version of the Whiplash Disability Questionnaire (WDQ), developed by Hoving et al., with 13 items about how pain influences the life situation each with a numerical

11-point scale (140-142). In the current context we modified the items by replacing the word "whiplash" with "low back or neck pain." This disability score was the mean of the 13 items.

Based on these scales, four dichotomized outcomes were defined grounded on what is believed to correspond to a clinical significant improvement (143-145):
a) improvement in pain: at least a two-step decrease (compared to baseline) in pain score (CPQ)
b-c) improvement in disability: at least a one-step decrease (compared to baseline) in disability score (CPQ and WDQ)
d) totally recovered: a pain score less or equal to 1 and a disability score equal to 0 (CPQ).

4.5.3.2 Secondary Outcomes

The secondary outcome was perceived recovery. Perceived recovery is a retrospective assessment considered to have great value in trials like this (100, 146), in this case measured by a single question "How have your symptoms changed since the trial started?" The ratings were on a numerical 11-point scale labeled "very much worse" (=-5), "no change" (=0) and "very much better" (=5). Based on this scale a dichotomized outcome was defined as; v*ery much improved* (having stated "I am very much better since the trial started"/ not very much *improved*). Other cut-off points for perceived recovery were also analyzed, but not reported in the article since the results were similar.

4.5.4 Statistical analysis

Power analyses based on the primary outcomes were performed in advance to determine the sample size. A total of 400 patients indicated a power of > 80% to detect a relative risk of 1.2-1.3 for a clinically important improvement in pain and disability.

All data registration was handled by an assistant not involved in the project, and the analyses were performed by a statistician not aware of the meaning of the allocation. The analyses were performed using an "intention to treat" principle aimed at analyzing patients in the group to which they were originally assigned and to keep the dropouts in the assigned group no matter what the reason (147). To estimate the impact of missing responses, additional sensitivity analysis for the primary outcomes was performed, using multiple imputations (148). Differences between the groups at baseline were tested using Chi-square tests. Changes in mean scores at follow-up compared to baseline, and differences in changes between groups were calculated by unpaired t-test.

To compare the groups regarding the dichotomized outcomes, relative risks (RR) and risk differences (RD) together with corresponding 95% confidence intervals (CI) were calculated. Mantel-Haenszel's method was used to investigate and adjust for potential confounding (149).

5 RESULTS AND COMMENTS

5.1 STUDIES I & II. LIFE EVENTS AND COPING STRATEGIES

Before this study was carried out was the role of life events and critical life changes in the onset of back and neck pain is not fully understood. The overall aim of the present study was to expand the knowledge about the occurrence of life events and how they affect the risk of low back and neck/shoulder pain.

The analyses of the material from the MUSIC-Norrtälje case-control study gave the following results. Life events outside work were more frequent than life events at work. About 63% of all controls reported at least one event and about 14% at least three events at work, whereas 89% reported at least one event and 45% at least three events outside work during the preceding five years. With regard to critical life changes, 56% of all controls had experienced at least one change at work, whereas 71% had experienced at least one change outside work during the preceding five years. Women reported more life events outside work than men, but there was no difference between women and men concerning number of life events at work.

In the analyses, life events and critical life changes were regarded as potential risk factors. The results showed that having experienced at least two life events the preceding five years was associated with an increased risk of neck/shoulder pain (OR=1.6, 95% CI: 1.1-2.4), and an experience of at least two critical life changes, that is a life event that had brought about a psychological or psychosocial lasting change was associated with an increased risk of neck/shoulder pain (OR=1.9, 95% CI: 1.3-2.7). A dose response relationship was not observed. No association between life events and risk of low back pain was observed but an association between at least two critical life changes at work and low back pain was found. Regarding the risk of neck/shoulder pain, a relative comparison showed that at least one critical life change at work implied a higher risk increase than at least one critical life change outside work (OR=1.4, 95% CI: 1.0-2.0). There were no systematic differences in odds ratios depending on when during the preceding five years the event took place.

The role of open and covert coping style in the onset of back and neck pain has, as far as we know, not been investigated before. Of special interest is to investigate the role of the coping style in concurrent stressful situations. Critical life changes constitute a kind of psychosocial stress that have been pointed out as a risk factor for neck/shoulder pain in Study I, based on the same material. The overall aim of study II was to explore the influence of a covert coping style on the onset of low back and neck/shoulder pain.

Since Study II is published as a “Letter to the Editor”, there is additional information in this text as compared to the published study.

It was more common among controls that women (28%) than men (16%) reacted with a covert coping style. Having a covert coping style was associated with an increased risk of neck/shoulder pain among women (RR=1.9, 95% CI: 1.2-3.0), but not among men (RR=0.9, 95% CI: 0.5-1.7). There seemed to be no difference between subjects with a covert and an open coping style with regard to occurrence of low back pain.

Since both a covert coping style and critical life changes were observed to be associated with increased risks among women, it was of interest to study the interaction between the two factors. An interaction was observed and the attributable proportion due to interaction (AP) was estimated as 0.5, 95% CI: 0.1-0.8 (Table 4). The interaction analysis indicate that a covert coping style was associated with neck/shoulder pain only when a stressor concomitantly was present (RR=2.2, 95% CI: 1.5-3.3); in the absence of a stressful exposure in the form of having experienced three or more critical life changes the preceding five years, no association between covert coping style and neck/shoulder pain was observed among women (RR=1.0, 95% CI: 0.6-1.7).

Table 4. Relative risk (RR) and attributable proportion due to interaction (AP), together with 95% confidence interval (CI), for neck/shoulder pain in women with different combinations of coping style and critical life changes.

WOMEN	**An open coping style.**	**A covert coping style.**
No or one critical life changes the preceding five years.	RR* = **1** n**= 35/149	RR = **1.0** 95% CI: 0.6-1.7 n** = 28/115
Three or more critical life changes the preceding five years.	RR = **1.1** 95% CI: 0.7-1.8 n** = 35/136	RR = **2.2** 95% CI: 1.5-3.3 n** = 66/153 *AP = 0.5* *95% CI: 0.1-0.8*

* Reference category. ** Number of exposed cases/number of exposed controls.

5.2 STUDY III. SMOKING, ALCOHOL AND LONG-TERM SICK LEAVE

The number of long-term sick listed persons due to back or neck pain is high in Sweden and other countries. The need for identifying risk factors for long-term sick leave in order to make effective prevention strategies was stated in a Swedish report (150). The roles of lifestyle factors for long-term sick leave due to back or neck pain is not fully understood. The aim of this study was to investigate the associations between smoking and alcohol consumption respectively and long-term sick leave due to back or neck pain.

In total, 6,532 were included in a cohort, classified as having "good health for working" at baseline, and to be at risk for becoming long-term sick listed (not sick listed at baseline). During the three-year follow-up, 177 persons had at least one spell of continuous sick leave for $\geq$28 days due to back or neck pain.

Smoking was associated with an increased risk of long-term sick leave due to back or neck pain. Compared with never smokers, the adjusted rate ratio (RR) for ever smokers was 1.8 (95% CI: 1.3-2.4) and for persons with more than 20 pack years 2.2 (95% CI: 1.2-3.9). There was no significant dose response relationship regarding smoking expressed as pack years and long-term sick leave due to back or neck pain (p=0.08).

Alcohol consumption tends to have a protective effect against long-term sick leave due to back or neck pain. Participants who drank alcohol twice per week or more often had a lower risk than those who drank once per month or less (RR=0.4, 95% CI:

0.1-1.1). Drinking more than 10 drinks per month compared with drinking less than two drinks per month associated with a lower risk (RR=0.5, 95% CI: 0.2-1.2). Compared only with never drinkers (people who never drink alcohol), alcohol users had a lower risk (RR=0.6, 95% CI: 0.3-1.0). There was a dose response relationship regarding alcohol consumption expressed as drinks/month and long-term sick leave due to back or neck pain (p=0.04).

5.3 STUDY IV. NAPRAPATHIC MANUAL THERAPY

The naprapathic profession is since 1994 a part of the Swedish health and medical care system, by the license from the National Board of Health and Welfare, for treating patient with pain and pain-related disability from the musculoskeletal system. Each year over 1.5 million naprapathic treatments are delivered in Sweden by around 900 licensed naprapaths. Despite this, no study had evaluated the effect of naprapathy as it is carried out in every day practice. The aim of this trial was to compare the effectiveness of naprapathic manual therapy (Index Group) and evidence-based care defined as support and advice on staying active and on pain coping strategies, provided by a physician (Control Group), for patients with pain in the back and/or neck lasting for at least two weeks, regarding pain, disability, and perceived recovery.

Four hundred and nine subjects were randomly assigned to two different treatments; naprapathic manual therapy given by one out of eight naprapaths (Index group) or evidence-based care and support on staying active and on pain coping strategies provided by one out of four a physicians (Control Group). The assigned patients had a mean age of 47 years, were mainly women (71%), and were mainly suffering from neck pain (58%). For many, duration of pain was more than a year (56%).

Baseline values and changes in the mean of the outcomes for subjects taking part in the follow ups at 7 and 12 weeks, respectively compared to baseline for these persons and difference in mean changes between groups are shown in Table 5. There were statistically significant changes within both groups compared with baseline, and there were statistically significant differences in changes between the groups favoring the Index Group for pain and disability at 7 and 12 weeks.

The similarity between groups as well as stratified analyses indicated no confounding when the relative risk and risk difference for the dichotomized outcomes was calculated. After 12 weeks, a higher proportion in the Index Group stated that they were *very much improved* (RR = 4.5, 95% CI: 3.0-6.8); had a clinically important *improvement in pain* (RR = 1.6, 95% CI: 1.4-2.0); had a clinically important *improvement in disability* (RR = 1.3, 95% CI: 1.1-1.6); and had *totally recovered* (RR = 2.7, 95% CI: 1.5-4.9). Table 6 that is not published in the article gives more detailed results in perceived recovery.

Among the patients in the Index Group, 98% received massage, 83% stretching, 57% spinal mobilization and 81% received spinal manipulation at the second consultation. Adverse reactions in the Index Group were recorded and none were serious, but minor short-term reactions such as muscle soreness, tiredness, and increased pain were reported, most commonly after the first and second treatments.

Table 5. Baseline values in pain and disability for the Index and Control groups, changes in the mean of the outcomes for subjects taking part in the follow up at 7 and 12 weeks, respectively, compared to baseline for these persons and difference in mean changes between groups.

	Baseline	**7 weeks**		**12 weeks**	
	Baseline value (95% CI)	Change* (95% CI)	Differences in change (95% CI)	Change* (95% CI)	Differences in change (95% CI)
Pain					
Index Group	5.5 (5.3-5.8) n=204	2.3 (2.1-2.6) n=189	0.8 (0.4-1.2)	2.9 (2.6-3.2) n=192	1.3 (0.9-1.7)
Control Group	5.4 (5.2-5.7) n=203	1.5 (1.2-1.8) n=182		1.6 (1.3-1.9) n=179	
Disability					
Index Group	2.7 (2.5-3.0) n=206	1.4 (1.1-1.7) n=192	0.8 (0.3-1.2)	1.5 (1.2-1.8) n=194	0.7 (0.2-1.2)
Control Group	2.8 (2.3-3.1) n=202	0.6 (0.3-0.9) n=180		0.8 (0.5-1.2) n=180	

***** The difference in the group mean of the outcomes at follow-up compared to baseline.

Table 6. The proportion of "improved," "much improved" and "very much improved" in the groups, the relative risk (RR), and the risk difference (RD) between the groups, together with 95% confidence intervals (CI).

Improvement		Index Group (imp/not imp)§	Control Group (imp/not imp)§	RR (95% CI)	RD (95%CI)
Three weeks					
	At least improved*	79% (154/41)	42% (78/106)	1.9 (1.6-2.3)	37% (28-46)
	At least much improved†	31% (60/135)	10% (18/168)	3.2 (2.0-5.2)	21% (13-29)
	Very much improved‡	8% (16/179)	2% (3/183)	5.1 (1.5-17.2)	6% (2-11)
Seven weeks					
	At least improved*	86% (165/27)	50% (89/88)	1.7 (1.5-2.0)	36% (27-45)
	At least much improved†	71% (136/56)	24% (43/134)	2.9 (2.2-3.8)	47% (38-56)
	Very much improved‡	45% (86/106)	9% (16/163)	5.0 (3.1-8.2)	36% (28-44)
Twelve weeks					
	At least improved*	84% (158/31)	55% (95/78)	1.5 (1.3-1.8)	29% (20-38)
	At least much improved†	76% (144/45)	32% (55/118)	2.4 (1.9-3.0)	44% (35-54)
	Very much improved‡	57% (107/82)	13% (22/153)	4.5 (3.0-6.8)	44% (35-53)

* At least improved means ≥1 on the 11 point scale ((-5) – 5) measuring improvement since the study started.

† At least much improved means ≥ 3 on the 11 point scale ((-5) – 5) measuring improvement since the study started.

‡ Very much improved means having stated that "I am very much improved since the study started" (5 on the 11 point scale ((-5) – 5) measuring improvement since the study started).

§ Numbers of improved/not improved, much improved/not much improved and very much improved/not very much improved respectively in the intervention groups.

6 DISCUSSION

6.1 STUDIES I & II. LIFE EVENTS AND COPING STRATEGIES

6.1.1 Main findings

Two or more life events or critical life changes, respectively, experienced during the preceding five years were observed to be associated with an increased risk of neck/shoulder pain, whereas, in general, no associations were observed in relation to risk of low back pain. The increased risks were most pronounced regarding changes experienced at work. There were no systematic differences in the observed odds ratios between men and women, nor did number of years within the five-year period since the event took place influence the results.

A covert coping style was more common among women than among men, and was observed to be associated with an increased risk of neck/shoulder pain among women but not among men. In general, no associations were observed in relation to risk of low back pain. A synergistic interaction between critical life changes and a covert coping style was observed among the women.

6.1.2 Methodological considerations

Strength in Studies I and II is the definition of the study base as adult inhabitants living in, and not working outside, the municipality, and the cooperation with all known caregivers in the area, even complementary and alternative ones, implying that a great majority of the subjects that had sought health care for low back and/or neck/shoulder pain during four years were included. We identified 1,148 cases among a population of approximately 17,000 persons. This group of cases probably also subsumes a great proportion of the serious episodes of back and neck/shoulder pain that occurred in the study population. A few cases might have traveled outside the municipality for care and some cases might have refused to or have not been offered to participate. In summary, we believe that a high proportion of eligible cases were identified.

To be able to study "new" episodes of back and neck pain, subjects that had sought care during the preceding six months were excluded. Considering the high incidence of back and neck pain, it is likely that many subjects have had earlier back or neck pain. Since information on previous back and neck pain was collected, we took that into consideration in the analyses. It turned out that back and neck pain earlier in life, for more than seven days in a row, was a strong predictor of low back pain (OR= 3.6; 95% CI: 3.0-4.4) and neck/shoulder pain (OR=4.4; 95% CI: 3.5-5.6), but was not a confounder in the analysis of life events and coping styles as risk factors. When subjects with earlier neck/shoulder pain were excluded from the analyses, life events and a covert coping style were still observed to be related to the occurrence of neck/shoulder pain, adding more validity to the observed relationship.

Strength in Study I is that the experience of life events was assessed by a careful interview, as suggested in a review of studies of life events and illness (151).

Around 70% of the controls (1,700) came to the examination and the interview. There is a risk that the controls that declined to enter the study differed from participating controls when it comes to coping style and experience of life events. If non-participating controls had a more covert coping style or had experiences more life

events than participating controls, there is a risk for selection bias in the form of an overestimation of the strength of associations.

Recall bias may occur if cases have better or worse recall of their life events or coping strategies than the controls. It is also conceivable that life events and coping strategies might influence care-seeking behavior and thereby give rise to selection bias. Given the disparity of the results regarding neck/shoulder and low back pain, respectively, it is highly unlikely that recall bias or selection bias could explain the observed association between life events, coping strategies and neck/shoulder pain, since we have no reason to expect recall and selection to differ between low back cases and neck/shoulder cases.

Given that the associations in Study II regarding women are valid, it is a bit surprising with the lack of association between a covert coping style and neck/shoulder pain among men. It is possible that the lack of association among men was due to chance, since the number of men was relatively low as reflected in the width of the confidence interval.

Confounding does not seem to be an appreciable problem in these studies, but we cannot exclude residual confounding from factors not measured.

In summary, we believe that the observed relationship between life events and coping strategies, respectively, and a new episode of neck/shoulder pain are for real and not totally explained by bias.

6.1.3 The results in comparison to other results

The association between life events and neck/shoulder pain has scarcely been investigated before. Results from earlier studies of the association between life events and low back pain are conflicting, probably due to different study designs, different definitions of exposure and different case definitions (71-79). Moreover, most of them have used self-administered life event questionnaires and not interview forms. The use of interviews in assessing life events has been recommended (151).

Some studies have shown the importance of rating the experience of the event as positive or negative. During the interview in our study, the interviewer noted the positive/negative value of the events. However, due to the complex nature of most life events and also to a questionable reliability in this part of the interview, it was not meaningful to report results stratified by experience.

The potential mechanisms behind the association between life events and risk of neck/shoulder pain are not clear, but there are several possible theories. Selye's stress theory, the general adaptation theory, stated that a non-specific accumulation of life changes during a short period of time would increase vulnerability to illness. The effort to adapt to a dramatic change would arouse the sympatho-adreno-cortical systems according to Selye (66).

Experimental studies have shown that mental stress results in an increased muscle tension in the neck and shoulder region (152, 153). There are several explanatory models which explain the correlation between the increased muscle tension and musculoskeletal disorders (154-157). We have no explanation for the disparity in associations between low back and neck/shoulder pain found in this study. According

to our knowledge, research on the correlation between stress and tension in muscles in the lower back area has not been done. There is some evidence of an effect of psychosocial factors at work on low back pain, but we have found no evidence of an effect of psychosocial factors in private life on low back pain in the literature (46).

Life events may be looked upon as psychological stress. Psychological factors were in a review shown to be more important in the development of pain and disability than are most biomedical and biomechanical factors. Among psycho-social and psychological factors were stress, distress or anxiety, cognitive functioning and pain behavior all found to be significant predictors (62-64, 158, 159).

We found a gender specific difference regarding prevalence of a covert coping style where women reported a covert coping style more frequently than men. This is in accordance with earlier research (65, 83, 84).

The role of open and covert coping style in the onset of back and neck pain has not, as far as we know, been shown before. The mechanisms behind how a covert coping style might cause neck/shoulder pain is unknown. The pronounced relative risk of neck/shoulder pain among women with a covert coping style when stress was concurrently present, indicate that coping style may have an impact on the consequences of stress.

6.2 STUDY III. SMOKING, ALCOHOL AND LONG-TERM SICK LEAVE

6.2.1 Main findings

We found that smoking was associated with an increased risk of long-term sick leave due to back or neck pain and, more surprisingly, that alcohol consumption tends to have a protective effect.

6.2.2 Methodological considerations

The study design and the large number of potential confounders taken into consideration increase the validity in this study. Still, residual confounding cannot be excluded.

Although there is a potential misclassification of the outcome, it is probably of minor importance since cases were consecutively reported independently both from the employer and the occupational health services.

The selection of participating county councils and local authorities was not random, since the investigation is part of the longitudinal HAKuL-Study, including demanding interventions at the workplace and rehabilitation of people on long-term sick leave. However, the participating county councils and local authorities are of different size and located in different parts of Sweden, and the majority of the different occupational groups in the county councils and local authorities are represented in the cohort.

Persons with “bad health for working” and persons on full-time sick leave due to any reason at baseline were excluded from the cohort, since exposures predicting long-term sick leave could have been changed because of impaired health status which would hamper the interpretation of observed associations. However additional analysis including those with “bad health for working” changed the associations only marginally.

Is there causality, that is, does smoking cause sick leave and does alcohol consumption prevent sick leave due to back or neck pain? The prospective study design, where the exposures are measured before the occurrence of the outcome, and the consideration taken to a relatively large number of confounders, indicates a causal relationship. Do the observed associations between smoking or alcohol and long-term sick leave apply to the presence of back or neck pain as well? Is sick leave due to back and neck pain a severe form of back or neck pain, or are other factors than the actual back or neck health status of more importance for the associations between smoking and alcohol consumption respectively, and long-term sick leave due to back or neck pain found in this study? In Sweden you are required to present a medical doctor's certificate for sick leave longer than seven days. Most persons with back or neck pain work despite their pain, but sometimes persons with back or neck pain seek a medical doctor either to obtain their opinion regarding if their work will aggravate the symptoms, or to explain that the pain is not consistent with their work. By the written medical certificate, the doctor certifies not only that a disease is present, but also that the disease results in limited capacity for work.

In summary, we believe that the associations found in this study are valid, even though there is a risk of residual confounding, and though the causal chains are complex, precluding strong statements about causality. The following conclusion was made: Our results suggest that smoking is a risk factor for long-term sick leave due to back or neck pain, and that alcohol consumption tends to have a protective effect.

6.2.3 The results in comparison to other results

The increased risk for long-term sick leave due to back or neck pain associated with smoking, is in inconsistent with the results from the Swedish systematic review from 2004 (56), but in line with more recently published studies (57-59, 61). The difference from the Swedish review may be explained by the thorough analyses in the present study where smoking was the main exposure and several potential confounders were considered. The study subjects included in the Swedish review were mainly men employed by manufacturing industries, whereas this study mainly included female employees in the public sector.

The tendency of a decreased risk associated with alcohol consumption in this study has not, to our knowledge, been found before. In a previous study, alcohol consumption among men was associated with an increased risk of long-term sick leave in general (160). The risk associated with alcohol consumption may differ between men and women and between different diseases. Additional analyses stratified by sex suggest a protective effect among women as well as among men in the present study, even though the men were much too few for valid analyses. The study population did not include many high consumers, which precludes studying the effect of heavy drinking.

One can establish that back or neck pain is an important part of the outcome "sick leave due to back or neck pain", and therefore it is of interest what the evidence is for the association between smoking or alcohol and back or neck pain. One review found no association between alcohol consumption and low back pain, but well-designed studies were considered lacking (161). Smoking has been found to be associated with non-specific back pain, sciatic pain, and neck pain in some studies. Croft et al. found no association between smoking and alcohol consumption respectively and neck pain in a longitudinal study (28). Mortimer et al. did not find smoking to be a risk factor

for low back pain in a study based on the MUSIC-Norrtälje Study (121). Tubach et al. found no associations between heavy smoking and low back pain, but between heavy smoking and sick leave due to low back pain in the same study (59), indicating that risk factors may differ between low back pain and sick leave due to low back pain. This was also seen by IJzelenberg et al. who found that risk factors differ between musculoskeletal complaints and musculoskeletal sickness absence. Work-related factors largely determine the occurrence of low back pain and upper-extremity complaints, whereas individual factors predominantly determine sick leave due to musculoskeletal complaints (162). What is causing the sick leave, apart from back or neck pain, is probably mainly cultural factors. Given that the adjustment in the analyses for socio-economic class is valid we would in summary emphasize that the associations between smoking and alcohol respectively and long-term sick leave due to back or neck pain found in this study are more related to the pain in back and neck, than to cultural factors.

The mechanisms by which smoking or alcohol consumption may influence sick leave due to back or neck pain is not known. The mechanism explaining the increased risk of smoking on back or neck pain may go through a decreased circulation in the tissues in the spine from nicotine, causing ischemic pain, decreased function and degeneration in connective tissues and muscles. The mechanism explaining a possible protective effect of alcohol consumption on back or neck pain may go through an anti-inflammatory effect that has been shown in studies of mice. In one of these studies, the authors concluded that low but persistent ethanol consumption delays the onset and halts the progression of collagen-induced arthritis by interaction with innate immune responsiveness in mice (163). Another mechanism might be the general relaxing effect alcohol may have on people, which probably affects the muscles in the back and neck as well.

6.3 STUDY IV. NAPRAPATHIC MANUAL THERAPY

6.3.1 Main findings

Naprapathic manual treatment were statistically and clinically significant more effective than evidence-based advice on staying active and on pain coping strategies for non-specific back and neck pain, after 7 and 12 weeks. Separate subgroup analysis indicated that naprapathy is effective both for back and neck pain patients.

6.3.2 Methodological considerations

The study design was pragmatic, allowing for differences in numbers and in lengths of treatment sessions between the groups and to some extent to adapt the treatments within the groups to the patients' conditions. The differences were allowed in order to evaluate the two treatments as they usually are performed in everyday practice. The content in the interventions was discussed in several meetings held in advance in order to standardize the treatments as far as possible without trespassing on the pragmatic design. Analyses of the treatments actually given in the Index Group showed that a majority of the patients had received a combination of massage, stretching and/or spinal manipulation/mobilization.

The non-specific effects of the hands-on approach and the potentially intensive patient-therapist interaction in the Index Group may have contributed to the observed differences between the groups. The fact that the differences still remained at the 12-week follow-up, i.e. several weeks after completed treatments suggests that the superiority of naprapathy is explained primarily by other factors, such as that the

combined manual techniques enabled patients to carry out physical activities to a greater extent. Among these non-specific effects are the impact of placebo, as in every other positive meeting between a patient and a caregiver. Double blind studies (blinding therapists and patients), which are a good way of controlling for placebo, are not consistent with evaluations of manual therapy in practice. In order to in some way compensate for the lack of a double-blinding design, we used self-reported outcomes in mailed questionnaires, and let the statistician making the analyses be blind to the meaning of the group assignments. Placebo effects depend on the expectations of the subjects. This was considered both in the design of the trial, as well as in the implementation of the trial. We put a lot of effort in performing all different stages so that the expectations should be as equal as possible on the two treatments to be tested. We also tried maintaining a high level of objectivity in the approach against the study persons in all situations. The four physicians in the study that all were experienced elucidated in discussions that they were eager to do their profession justice and of course provided the best care, as also was the case with the eight naprapaths.

It would have been good to measure the subjects' expectations of the effect of the interventions before the trial started. That was not possible to do since this would have demanded a detailed explanation of the control intervention which would have been like exposing all subjects to this intervention. Instead we asked an initial question about why they considered participating in the study, and this showed that 60% of all assigned wanted to see a naprapath, which may indicate an expectation bias.

Strengths of our trial include the great number of patients and the relatively few dropouts, which led to a high internal validity. The kind of back and neck pain studied is frequent, enabling a generalization of the results to a large proportion of the population. One could claim that the differences between groups concerning frequency and length of treatment sessions are a limitation, but the intention was to compare these treatments as they work in everyday practice (a naturalistic protocol), even though recruiting by advertising may have included a group that normally does not seek care for their pain.

The fact that all outcomes were self-reported could be considered a limitation, but research shows that a self-administered examination may be used in studies of relationships between exposure and disorders in the musculoskeletal system (164). The patient's opinion is considered to have a great value when a "observer-based performance measure" does not exist (100). The difference between groups was most pronounced for perceived recovery, a retrospective assessment of different aspects of health. It mirrors pain and disability as well as patient satisfaction and expectations of the assigned treatment and is an important compliment to pain and disability measurements whenever the results are to be applied in clinical practice (146, 165).

On balance, with consideration taken to the strength and the limitations, we believe that the associations found in this study are for real. The trial adds to the knowledge that recommending a combination of manual therapies, as naprapathic manual therapy, may be an alternative to consider in primary healthcare for patients with back and neck pain. Compared to evidence-based care provided by a physician, naprapathic manual therapy implied a greater improvement in pain and disability as well as a higher success rate of recovery.

6.3.3 The results in comparison to other results

No study is published that has evaluated the effects of naprapathic manual therapy, which preclude comparing the results to earlier findings. Nevertheless, there are trials evaluating combined manual therapies performed by other therapists, with conflicting results. These studies usually have a pragmatic approach. The intervention has often been adapted to each participant in the study, according to what the therapist judges to be suitable (but within the framework of the form of manual therapy that is to be evaluated).

Koes et al. carried out a randomized controlled trial that compared the effectiveness of manual therapy (spinal manipulation/mobilization), physiotherapy (exercises, massage, heat and/or electrotherapy), treatment by a general practitioner (prescription of medications, advice on posture, physical activity, rest, etc.) with placebo treatment (ineffective electrotherapy) for 252 patients with non-specific back or neck pains (166). Patients were followed for 12 weeks, and the results showed that both manual therapy and physiotherapy reduced the pains more effectively than did treatment by the general practitioner. No differences were seen in effectiveness between manual therapy and physiotherapy. Even the placebo group improved to a greater degree than did the general practitioner-treated group.

A smaller study (n=49) showed that patients with long lasting low back pain who had received manual therapy (spinal manipulation/mobilization and stretching, and strengthening and limbering-up exercises) exhibited a significantly greater improvement after four weeks, six weeks, and one year than did those who had received only exercise therapy (167).

A study by Hoving et al. included patients non-specific neck pain with a duration of two weeks (n=183) (168). They were randomly assigned into three treatment groups: *Manual therapy*: Six different therapists gave muscular mobilization techniques, spinal mobilization, as well as coordination and stabilization techniques for the neck muscles. A maximum of six treatments were given at one-week intervals. *Physiotherapy*: A combination of different treatment techniques, with the emphasis on active physical exercises, including strength and mobility exercises, posture exercises, stretching, and relaxation exercises. Manual traction, massage, electrotherapy, or heat/cold interventions could also be used. Five different physiotherapists gave treatments twice a week, with a maximum of 12 treatments. *Continued treatment by a general practitioner:* Continued standard treatment was given by a doctor with, for instance, advice about prognosis, psychosocial factors, self-help, ergonomics, and assurance that the patient would improve. These patients also received an information folder of ergonomic advice and exercise descriptions. If needed, the doctor gave them prescriptions for medications. The patients were booked for a 10-minute follow-up visit every other week. After seven weeks 68% in the manual therapy group, 51% in the physiotherapy group, and 36% in the general practitioner group were completely recovered or greatly improved, and the manual therapy group had statistically significant lower pain intensity as compared with the other groups. In a follow-up study assessment was made of the cost-effectiveness, showing that the total costs that could be directly attributed to the patients' problems were significantly lower for the manual therapy group as compared with those for the other two groups (169). The authors concluded that manual therapy is more effective and less costly for treating neck pain than physiotherapy or care by a general practitioner. In the long-term follow-ups it was seen that the differences between the

groups after 13, 26, and 52 weeks decreased and that they were no longer statistically significant after one year (170). To sum up, manual therapy gave a faster improvement in neck pain than did physiotherapy or treatment by a doctor, but the groups had the same remaining degrees of pain after one year.

In a smaller study where 132 patients with non-specific back pain were randomly assigned for treatment with physiotherapy, spinal manipulation, or physical exercises with stretching, it was also shown that manual treatment was more effective than the other methods (171).

Skargren et al. compared the effects and costs of chiropractic to physiotherapy among 323 low back and/or neck pain patients, and found no differences between the groups after 6 or 12 months (172, 173)

A multi-center study with a pragmatic approach was unable to show that manual treatment is more effective than other treatments (174). Three hundred and fifty patients with non-specific neck pains were divided into three groups that received the following treatments: 1. Individually adapted advice and exercise programs as well as manual therapy in eight sessions for six weeks, 2. Individually adapted advice and exercise programs as well as electrotherapy, and 3. Individually adapted advice and exercise programs alone. The patients were compared after six weeks and six months, and no statistically significant difference in symptoms was seen between the groups.

In summary, many studies of combined manual therapy shows that it is an effective treatment strategy (166-168, 171) just in line with the results in this study, but there are as well studies that did not find advantages with combined manual therapy (172-174).

The conclusion in Study IV was: Compared to evidence-based care provided by a physician, naprapathic manual therapy implied a greater improvement in pain and disability as well as a higher success rate of recovery. The trial adds to the knowledge that recommending a combination of manual therapies, as naprapathic manual therapy, may be an alternative to consider in primary healthcare for patients with back and neck pain.

6.4 GENERAL DISCUSSION

6.4.1 Measuring pain

The fact that the experience of pain is a subjective experience makes it difficult to measure in an objective way. Most people have pain now and then but the pain is not always disabling. In pain research it is important to judge to what extent pain interferes with everyday life as job, leisure time and social situations. Disability is a complex phenomenon that incorporates physical pathology, the individual's response to that physical insult, and environmental factors that can serve to maintain the disability and associated pain (175). The most common way to measure pain and pain-related disability is by questionnaires, and often body region specific questionnaires are developed. In clinical studies where observer-based performance measures do not exist, the patients' opinions are of great value when recovery is assessed. For that purpose pain and disability questions in clinical studies should be combined with a retrospective assessment of perceived recovery (104, 146).

6.4.2 Statistical analysis of pain

When using self-reported outcomes on pain, data is collected that are measured with the ordinal scale of measurement, ranking subjects according to the grade of pain. These kinds of assessments generate ordered categorical data with lack of information regarding size and inter-categorical distances. What can and what cannot be done in statistical analyses with the ordinal scale of measurements have been discussed a great deal (176, 177). The limited mathematical properties of ordered categorical data mean that many of the most common statistical methods for evaluation of change, as Student's paired t-test and the Wilcoxon sign rank test, are not appropriate to use as they are based on differences (178). By dichotomizing the outcome, for example in recovered/not recovered, assessments on scales and questionnaires can be analyzed with methods as logistic regression that generate informative point estimates together with 95% confidence intervals (CI).

Research on the effect of treatments as manual therapy on back and neck pain includes several methodological challenges in addition to analyzing categorical data. One is the issue of defining clinically important changes. Pain intensity is frequently measured on an 11-point pain intensity numerical rating scale, where 0=no pain and 10=worst possible pain, as in the Chronic Pain Questionnaire by von Korff (136-139). It has been suggested that a 2-point change in pain is clinically important (143, 144). In direct comparisons of the mean or median group values of pain, a big change among a few participants may have a great impact on the group results. One way of comparing groups but at the same time considering individual effects of the treatments under study is to compare the pain ratings at baseline and at follow up for every study person. The proportion of study persons with a clinically important improvement is then compared between the groups to get a more clinically interesting result.

6.4.3 Recruitment strategies in studies on back and neck pain

Back and neck pain may be of different and unknown origins, and not all people with pain seek care or become sick-listed. Most back and neck pain are said to be non-specific. In research on back and neck pain, different recruitment sources may target different types of back and neck pain, and persons with different baseline characteristics, which might be important to consider in the interpretations of the results. A methodological problem is the fact that when trial recruitment starts, the supply of suitable patients often becomes a fraction of what it was assumed to be before the trial began, also called "Lasagna's law" (179). This result in that the decisions about how to recruit patients are often based upon practical aspects more than scientific considerations.

6.4.3.1 Recruitment of back and neck patients in the thesis

The aim of this thesis was to study back and neck pain, and different recruitment strategies were used to identify and include the back and neck cases in the studies. This might raise the question if the findings in the three different materials may be generalized to all three study populations. Are life events and coping strategies only risk factors for care seeking for low back and neck/shoulder pain (Studies I and II)? Are smoking and alcohol related to back and neck pain in general, or only to long-term sick leave due to back and neck pain (Study III)? Is naprapathic manual treatment a good alternative to back and neck patients in primary care, or only to persons that want to take part in trials on request from advertising (Study IV)?

Cases that have sought care

In the MUSIC-Norrtälje case-control study (Studies I and II), those who sought care for back and neck pain within the community of Norrtälje were recruited. A back or a neck pain case is a person who has sought care or treatment for a new episode of low back pain or neck/shoulder pain. The ambition was to find all care seekers in the municipality during the study period of four years. That is why efforts were made try to find all caregiver to whom a care seeker might come. The 75 identified caregivers in the municipality were physicians, naprapaths, chiropractors and physiotherapists as well as alternative caregivers such as osteopaths, massage therapists and homeopaths.

What is characteristic for these back and neck pain cases? It is probable that those who seek care for their back and neck problems have relatively severe complain and disabling pain. These patients might be important to include in studies not only regarding risk factors, but also regarding effective treatment strategies. Care seekers probably differ from back and neck pain cases that do not seek care in several ways. They might have a higher level of external locus of control, and they might be more interested in care and sick leave than in getting well. On the other hand, it might be the other way around. Those who seek care might be more anxious to recover.

In this group are also patients that were referred to a specialist. They might have a more complex etiology to their complains, and they might be worried and have low expectations for recovery, which might be important to consider in interpreting the result of clinical trials.

To recruit cases among those who seek care is probably a cheap way of recruiting cases, even though it is time-consuming and demanding and effort are required in visiting and motivating the participating caregivers.

Cases on sick leave

In Study III based on the HAKuL-Study, persons among a group of employees in the public sector in Sweden who became long-term sick listed (for $\geq$28 days) due to back and neck pain during three years follow-up, were identified.

At least two things must be present when long-term sick leave is an alternative for the patient: the disease (back or neck pain), and a workability that by a physician is judged to be reduced in relation to the work tasks the patients ordinarily perform. Is sick leave due to back and neck pain a severe form of back or neck pain, or are other factors than the actual back or neck health status of more importance for the potential associations? In a review on sick leave, it was stated to be important to differ between the cause of disease and the cause of sick leave, which is a methodological challenge, especially when it comes to the interpretation of the results (150). Sick leave due to back and neck pain is possibly to be looked upon as a severe form of back and neck pain when it comes to studies about causes. When return to work is studied, other things than the actual back and neck pain might be important. Sick leave is probably a risk factor for not recovering from back and neck pain. Research on such patients is important not only because of the suffering, but also since they are the most costly group of back and neck patients to society.

Cases recruited by advertising

In the BJÖRN-Trial (Study IV) back and neck pain patients were recruited by advertising among employees at two big public companies in Stockholm. Who are those persons? Of course the groups of back and neck pain patients included in the two previously described populations are present: those who have sought care and those who have been or still are on sick leave due to back and neck pain. Among the included in the BJÖRN-Trial, more than half of the included had sought care for back and/or neck pain, and one fifth hade been on sick leave due to back and neck pain for the preceding six months. One may speculate that recruitment by advertising mainly attracts patients whose symptoms are not severe enough to demand care. Another possibility is that you by advertising reach cases that have not received help when they earlier have sought care.

If the advertising is successful, many potential study persons might contact the project in a short time, which also requires staff resources. Some of the cases that are recruited by advertising about scientific research might be more curious about participating in the project, than in getting help, which also requires staff resources to handle.

Baseline comparison of the cases

Since back and neck pain and disability were measured with the same questionnaire at baselines in the three groups of patients, they may be compared regarding their levels of pain and pain-related disability, as a measure of the severity of the back and neck pain they had. The Chronic Pain Questionnaire (CPQ) which is a reliable way of measuring pain and disability was used in all three data collections (136-139). In Table 7 some basic characteristics together with the pain and disability levels at baseline are reported. A comparison shows that pain and disability levels were more or less the same in the care-seeking group (MUSIC-Norrtälje Study) and the advertising group (BJÖRN-Trial materials), even though the samples differ in the education level. As expected the pain and the disability levels are higher in the long-term sick leave group (HAKuL-Study material). It might be important to notice that the retrospective period in the questions was six months in the MUSIC-Norrtälje Study and in the HAKuL-Study, but only four weeks in the BJÖRN-Trial, and that the response rates on these questions were quite low in the HAKuL-Study (60%).

Table 7. Sex, age, education, pain intensity and pain-related disability among back and neck pain patients at baseline, in the study samples in the thesis.

Characteristics	Cases in MUSIC-Norrtälje (n=1,148)	Sick leave due to back and neck, HAKuL (n=177)	All included in BJÖRN (n=409)
Women, %	62	93	71
Age, mean	40	48	47
University education, %	13	17	54
Pain intensity, (0-10) (95% CI)	4.6* (4.5-4.7)	6.8** (6.5-7.1)	5.5* (5.3-5.6)
Pain-related disability ,(0-10) (95% CI)	2.9* (2.7-3.0)	6.7** (6.3-7.1)	2.8* (2.5-3.0)

* Response rate 100%. ** Response rate 60%.

6.4.3.2 The effect of recruitment strategies in other studies

Studies included in evidence-based reviews often have used different strategies to identify the study persons. An example of this is a Cochrane Review on spinal manipulative therapy for low back pain (12). Randomized controlled trials (RCT) that evaluated spinal manipulative therapy for patients with low back pain, with at least one day of follow-up, and at least one clinically relevant outcome measure, were included in the review. The types of participants in the studies considered for participation were patients from primary, secondary and tertiary care regardless of duration and radiation pattern. The methodological qualities of the trials were assessed by the quality list from the Cochrane Back Review Group (180). Thirty-nine RCTs were included, and the conclusion was that there is no evidence that spinal manipulative therapy is superior to other standard treatments for patients with acute or long lasting low back pain.

We were able to identify 32 out of the 39 included articles in the review and the recruitment strategy in each and one of those were studied. Table 8 summarizes their way of recruiting low back pain cases:

Table 8. Summary of recruitment strategies in a Cochrane Review on spinal manipulative therapy for low back pain (12).

Low back pain cases	Number of articles
Had sought care in the primary care	17
By referral to specialists	8
By advertising	2
By a combination of care seeking and advertising	4
Not described in the article	1

The conclusion about the effect of spinal manipulation was drawn without consideration taken to which way back and neck pain patients had been recruited/identified, indicating that the authors of the review did not find recruitment strategies to be that important for the validity of the review.

A study of Veenhof et al indicates that the recruitment strategy was not important for the outcome of an intervention tested in a randomized controlled trial (181). They studied the impact of two different recruitment strategies on the study population and on the outcome, in a RCT involving patients with osteoarthritis of the hip and knee. Since it was a challenge to include patients to the RCT, they used two different recruitment strategies: referrals by physiotherapists (PT group, n=110) and invitation by newspaper articles (NP group, n=90). The result of the comparisons was that recruitment methods do affect the clinical characteristics and physical function at baseline for the patients recruited to the study, indicating that different recruitment methods attract different subjects. The NP group was higher educated and reported less pain and tiredness at baseline, although more joints were affected with osteoarthritis. But recruitment strategies did not affect the treatment outcome. After adjusting for the baseline differences, the effect of treatment (two exercise programs) after 13, 39 and 65 weeks were comparable for the groups, for all outcomes.

In conclusion, the study persons in the three materials in this thesis all had considerable pain and pain-related disability. The care-seeking group and the advertising group were almost equally affected. Considering the careful confounding controls in the studies, it is probable that the associations found in the thesis to a large extent apply to back and neck pain regardless of the recruitment strategies, even though they also are related to care-seeking behavior and other cultural differences reflected in sick leave patterns. It may however be important to consider the study population from which the cases were identified and not to generalize the findings to groups of back and neck pain patients that are not studied.

7 CONCLUSIONS AND SOME FUTURE PERSPECTIVES

Back and neck pain of several kinds in relation to different exposures have been studied with epidemiological methods in this thesis. The following conclusions were drawn based on the included studies:

- Life events and critical life changes are of importance for the risk of neck/shoulder pain of the kind that people are seeking care for, whereas their associations with regard to risk of low back pain are more uncertain.

- A covert coping style seems to be of importance in the onset of neck/shoulder pain of the kind that women are seeking care for. There is an indication that coping style has an impact of the consequences of stress on neck/shoulder pain in women.

- Smoking is a risk factor for long-term sick leave due to back or neck pain. Alcohol consumption tends to have a protective effect against long-term sick leave due to back or neck pain, at least among women in the public sector.

- Compared to evidence-based care provided by a physician, naprapathic manual therapy implied a greater improvement in pain and disability as well as a higher success rate of recovery. Recommending a combination of manual therapies, such as naprapathic manual therapy, may be an alternative to consider in primary healthcare for patients with back and neck pain.

Some future perspectives

In discussions about how to treat patients with back and neck pain, there is more and more focus on evidence-based medicine. Overwhelming evidence is present for the effectiveness of non-specific advice on staying active and on broad cognitive programs for back and neck pain. On the other hand, there is a growing interest, demand and evidence for more precise diagnoses in back and neck pain, and for detailed-based rehabilitation programs including spinal manipulation and precise core stability exercise that focus on details in the anamnesis as well as in the clinical findings. That is a bit of a paradox and there is probably a need for both approaches. But who needs the more detailed treatments? There is a big need for developing more specific diagnostic methods and better and internationally accepted definitions of back and neck pain. By that more specific groups of patients can be defined on which research can be performed. In broad groups of patients potential risk factors can be studied in more effective and valid ways if we can conduct stratified analyses based upon reliable subgroups. Further, clinical trials where the effect of treatments is tested can be performed in more homogeneous groups of patients. These will probably eventually give us evidence-based guidelines for different well-defined subgroups of back and neck pain patients to use in clinical settings.

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