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Sanna Kääriä

Low Back Disorders in the Long Term among Employees in the Engineering Industry

A Study with 5-, 10- and 28-Year Follow-ups

JYVÄSKYLÄN YLIOPISTO

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Esitetään Jyväskylän yliopiston liikunta- ja terveystieteiden tiedekunnan suostumuksella julkisesti tarkastettavaksi yliopiston Villa Ranan Blomstedtin salissa helmikuun 26. päivänä 2010 kello 12.

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ABSTRACT

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The aim of this study was to investigate the prevalence, persistence, and incidence of low back pain (LBP), its associations with neck pain (NP), and predictive factors for low back disorders severe enough to lead to hospital admission. In addition, the relationships of clinical findings in the low back with LBP were examined.

A sample of 902 subjects was drawn from among employees (n=4750) of a corporation in the engineering industry. During the follow-up period of 1973-2000, 232 subjects of the cohort died. In 1978, 748 subjects (84% of the survivors), in 1983, 654 subjects (76%), and in 2000–2001, 546 subjects (81%) responded to the questionnaire. LBP and NP were inquired using the recall period of 12 months.

At baseline, 54% reported LBP; 29% local pain and 25% radiation of LBP to the leg(s). LBP was a very persistent symptom. Of those with LBP at baseline, 75%, 73%, and 88% reported similar symptoms at the 5–, 10–, and 28–year follow-ups, respectively. Radiating LBP was more persistent than local LBP. The prevalence of radiating LBP, but not that of local LBP, increased during follow-up.

LBP co-existed commonly with NP. Both local and radiating LBP doubled the risk of local NP at baseline. Radiating LBP trebled the risk of radiating NP. These associations remained stable as the cohort aged. Both local and radiating LBP at baseline predicted new reports of radiating NP at the 5- and the 10-year follow-ups among subjects free of radiating NP at baseline.

The clinical findings were associated with LBP at baseline, stronger with radiating than with local pain. In prospective analyses, severe clinical findings predicted new reports of radiating LBP at the 5- and 10-year follow-ups with the odds ratio of 3.8 and 1.9, and new reports of local pain in the 10–year follow-up (4.1), compared to the group of no findings.

Fifty-one subjects of the sample were hospitalized for low back disorders during the follow-up. The risk of hospitalization was threefold by self-reported chronic back disorders, back-related work absenteeism, and frequent LBP, and almost fourfold by radiating LBP.

Overall the results show that LBP continues to be a common disorder in older adults, and that it often occurs in tandem with neck pain. Radiating LBP seemed to be particularly closely linked with clinical findings and with radiating NP. The results improve understanding of the natural course and consequences of LBP, and give weight to the suggestion of differentiating local from radiating pain in population studies.

Keywords: clinical findings, cohort study, employees, hospitalization, low back pain, neck pain

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LIST OF ORIGINAL PUBLICATIONS

This thesis is based on the following four original publications, which are referred to in the text by their Roman numerals:

I Kääriä S, Luukkonen R, Riihimäki H, Kirjonen J, Leino-Arjas P. Persistence of low back pain reporting among a cohort of employees in a metal corporation: A study with 5-, 10-, and 28-year follow-ups. *Pain* 2006;120:131–137.

II Kääriä S, Solovieva S, Leino-Arjas P. Associations of low back pain with neck pain. A study of industrial employees with 5-, 10-, and 28-year follow-ups. *European Journal of Pain* 2009; 13:406–11.

III Kääriä S, Mälkiä E, Luukkonen R, Leino-Arjas P. Pain and clinical findings in the low back. A study of industrial employees with 5-, 10-, and 28-year follow-ups. *European Journal of Pain* 2009 (in press).

IV Kääriä S, Kaila-Kangas L, Kirjonen J, Riihimäki H, Luukkonen R, Leino-Arjas P. Low back pain, work absenteeism, chronic back disorders, and clinical findings in the low back as predictors of hospitalization due to low back disorders. *Spine* 2005;30:1211–8.

ABBREVIATIONS

BMI	Body Mass Index
HRR	Hazard Rate Ratio
ICD	The International Classification of Diseases
LBP	Low back pain
METELI	Working conditions, health and physical activity among personnel in metal industry (in Finnish: Metalliteollisuuden henkilöstöjen työolosuhteet, terveydentila ja liikuntakäyttäytyminen)
NP	Neck pain
OR	Odds Ratio
PR	Prevalence Ratio
ROM	Range of motion
RR	Relative Risk

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ORIGINAL PUBLICATIONS

1 INTRODUCTION

Almost every person experiences an episode of low back pain (LBP) sometimes within his or her lifetime, often repeatedly. LBP is a common cause of visiting a general practitioner and is among the leading causes of sickness absence from work and of disability pensions. Therefore, the impact of LBP on individuals in terms of personal suffering and cost and the economic impact on society is considerable.

Pain as an individual experience is a multidimensional phenomenon, including physiological, cognitive, emotional and even social aspects, and it is difficult to measure it in a comprehensive manner. Approaches and tools for the measurement of LBP vary a lot in the literature. Information is usually gathered by questionnaire or interview with attention to, say, the frequency, severity, duration and location of pain, and time since the latest episode. In some studies the functional capacity of the low back among persons with LBP has been studied. In most epidemiological studies on LBP, the outcome has been defined without reference to pain being local or radiating. However, LBP radiating to the leg has been implicated as being potentially more serious than local pain in its consequences.

The natural history of LBP is deficiently understood. We do not have sufficient information of, particularly, the long-term development of LBP with increasing age. Furthermore, LBP may not occur in isolation from other musculoskeletal pain. The aim of this study was to increase the knowledge base of the occurrence and consequences of LBP, and its relationship with neck pain, by following up a cohort of employees over a period that covered almost three decades.

2 REVIEW OF THE LITERATURE ON LOW BACK PAIN

2.1 Origin and classification

Generally, LBP is defined as pain and discomfort between the 12th rib and the inferior gluteal folds, occurring with or without leg pain. Thus, LBP is a symptom, not a disease. In the literature, there is no consensus on the definition of LBP and its classification for diagnostic purposes. In addition to pain during spinal movement or continuous ache, subjects with LBP may describe other related symptoms such as stiffness, tightness, or a sensation of pressure or tingling. There are also signs sometimes connected with LBP, such as a restricted range of motion (ROM) of the spine, muscle contraction, or neurological signs. In most cases the cause of LBP remains unknown: a patho-anatomical diagnosis is possible only in about 15% of acute cases (Devereaux 2003).

LBP may arise from mechanical strain or trauma in the spinal structures. The source of acute LBP can be in any of the structures of the spine that receive innervation: the back muscles, ligaments, facet joins, degenerated intervertebral discs, dura mater, lumbar vertebrae, pelvic bones or the sacroiliacal joint, when affected by disease or disorder. It is assumed that the most common causes of LBP are injuries in muscles and ligaments (Deyo and Weinstein 2001, Meleger and Krivickas 2007). Other possible specific causes are degenerative disc and joint diseases, inflammatory conditions, infective and neoplastic causes, metabolic bone disease, trauma and congenital diseases, referred pain from different origins, or psychogenic pain (Krismer and van Tulder 2007). Pain can also be due to problems in organs around the spine. LBP can be due to problems in the vascular, gastrointestinal, uterine or renal systems (Devereaux 2007). However, the great majority of LBP is nonspecific, i.e. no direct cause for the pain can be determined.

LBP is often categorized based on the duration of symptoms. Acute pain is defined as pain lasting up to six weeks; subacute pain as pain lasting between 6 weeks and 3 months, and chronic pain as pain persisting for more than 3 months (IASP 1986). Recurrent pain refers to a new pain episode following a symptom-free period. The differentiation based on the duration of symptoms does not take into account the onset or the severity of the pain.

LBP may also be classified into subgroups based on the anatomical distribution of symptoms: local LBP, LBP with leg pain, and referred pain from different origins (Devereaux 2003). In the literature local LBP is usually labelled nonspecific.

LBP with leg pain is common (Waddell 2004). In the literature, this variant is known by a range of terms and there is no consensus about its precise definition. LBP with leg pain is characterized by pain that radiates from the low back to the leg (Koes et al. 2007); hence the synonym radiating LBP. It occurs often unilaterally in a lower limb, and may be related to neurological signs such as muscle weakness, reflex changes, and numbness in the distribution of the affected nerve root (Devereaux 2007). Although the sources of radiating LBP can be manifold (see above), the most common causes probably are herniation of the nucleus pulposus of a lumbar intervertebral disc to the spinal canal or degenerative spinal stenosis (Koes et al. 2007).

The term radiating LBP refers to pain arising from proximal irritation of the sciatic nerve. The most frequent sources of such irritation are intervertebral disc herniation or other degenerative phenomena in the spine, like osteophytes, hypertrophy of a facet joint (Tsao 2007), or spondylolisthesis (Deyo and Weinstein 2001). In addition, inflammation may play an important role in the manifestation of radiating LBP (Kobayashi et al 2005, Tarulli and Raynor 2007). When radiating LBP is due to nerve root compression, it characteristically shoots down along the dermatome of the affected nerve root to below the knee level and often to the foot or toes. Compared to radiating LBP, true nerve root pain is infrequent (Waddell 2004).

The proximal sciatic nerve can also be compressed by the piriformis muscle in the region where it crosses the nerve (Kirschner et al. 2009). Possible symptoms are buttock pain with or without a radiating component down the leg, paraesthesia, numbness and weakness (Stewart 2003).

According to the literature, lumbar intervertebral disc disorders with nerve root compression were related to different symptoms and signs such as leg pain, sensory loss and motor abnormalities or weakness (Tarulli and Raynor 2007). Pahl et al. (2006) evaluated the impact of four common spine diagnoses (herniated nucleus pulpous with radicular pain, lumbar spinal stenosis without deformity of spondylolisthesis, degenerative spondylolisthesis, painful disc degeneration / spondylosis) on the overall health status of patients. A diagnosis of herniated nucleus pulpous with radiating pain had the greatest harmful impact on a patient´s health.

2.2 Risk factors

LBP has multiple individual and environmental risk factors, including work-related factors. Among the reported individual risk factors are high stature, overweight, smoking, and low or extreme levels of physical activity (Heliövaara 1989, Leboeuf-Yde 2000, Riihimäki 2005, Anandacoomarasamy et al. 2008, Shiri et al. 2007, Shiri et al. 2009, Heneweer et al. 2009), as well as psychosocial factors like distress and depression (Macfarlane et al. 2008). Recently, evidence has emerged on genetic influences contributing to back pain and disc degeneration (Sambrook et al. 1999, Hartvigsen et al. 2004, MacGregor et al. 2004, Solovieva et al. 2004, Noponen-Hietala et al. 2005, Chan et al. 2006, Battié et al. 2007).

Several reviews have underlined the significance of physical workload in the genesis of LBP (Riihimäki 1995, Hoogendoorn et al. 1999, National Academy Press 2001). Relationships have been reported between LBP and heavy physical labor, including twisting and bending of the trunk, lifting heavy loads, whole body vibration, and static work postures. However, evidence based on prospective studies is conflicting (Bakker et al. 2009). The so called "healthy worker effect" that tends to transfer workers with health problems from heavy work to lighter tasks and from active work to the use of disability benefits or to unemployment may complicate the study of the associations (Kaila-Kangas et al. 2009).

Psychosocial factors at work, such as low job control, high demands, and low co-worker support, monotony, and work dissatisfaction have received increasing attention in the literature (Leino and Hänninen 1995, Hoogendoorn et al. 2000 and 2001, Harkness et al. 2003, Rugulies and Krause 2005) as possible risk factors of LBP. In a recent review of systematic reviews of literature it was found that high job demands and low job satisfaction were most consistently associated (4 reviews positive from 6) with LBP (Macfarlane et al. 2008).

Population-based studies have shown that there is an inverse relationship between socioeconomic status and low back pain (Leino-Arjas et al. 1998, Hagen et al. 2000, Latza et al. 2000, Dionne et al. 2001). As indicators of socioeconomic status educational level, income, and occupational class have been used. High workload, mental distress, and even lifestyle related risk factors of LBP may cluster to lower socioeconomic groups. However, in the study of Latza et al. (2000) the relationship between educational level and LBP among workers aged 25-74 years in Germany persisted after adjusting for occupational class or work tasks.

The consensus report by Greenspan at al. (2007) showed that women report more painful health conditions and have a higher sensitivity to pain than men. Furthermore, in many studies women have reported more often musculoskeletal pain than men (Bergman et al. 2001, Kopec et al. 2004, Hartvigsen et al. 2006), but the results of the studies are not consistent (Hagen et al. 2006, Webb et al. 2003).

2.3 Incidence and prevalence

The reported incidence rates of LBP vary a lot. According to a review by Andersson (1999) the annual incidence of back pain is estimated to be between 10% and 15% in the adult population. However, in a study by Waxman et al. (2000), the estimated annual incidence rate within the adult population was as low as 4% in the United Kingdom.

In a Canadian National Population Health Study of persons aged 18 years and over, the risk of new-onset back pain was 8% for men and 9% for women over a two-year follow-up period (Kopec et al. 2004). The incidence rate increased up to the age group of 45–64 year olds and decreased slightly thereafter (Kopec et al. 2004). Papageorgiou et al. (1996) studied the one–year cumulative incidence among adults in the UK. The incidence was 3% for men and 5% for women among those who visited general practitioners due to a new episode of LBP, and 31% for men and 32% for women among those who did not consult a general practitioner.

Cassidy and colleagues (2005) studied the incidence of LBP among adults aged 20–69 years old in Canada. Of 318 participants without LBP at baseline, 19% reported the onset of LBP over a one–year follow–up period. Consistent with this, Jacob (2006) reported a similar annual incidence of 18% among an adult cohort in Israel. When considering a longer period of time, the incidence rate increased. In a study of 148 randomly selected Veterans Affairs outpatients aged 35–70 years old, the three-year incidence of LBP was 67% (Jarvik et al. 2005).

It is very difficult to compare different studies on the prevalence of LBP due to the large variation in study populations and in the definition of LBP. In a comprehensive systematic review of the literature between 1966 and 1998 it was shown that one–year prevalence ranged from 22% to 65% among persons aged 15 years or more (Walker 2000). In a representative sample taken in Finland in 2000, approximately 77% of men and 76% of women aged 18 years or more reported having suffered from LBP at least once during their lifetime, and about 30% during the past month (Heistaro et al. 2007). In this study, the prevalence of radiating LBP was 30% in men and 40% in women (Heistaro et al. 2007). The prevalence rates of radiating pain increased with age up to the age group of 55–64 years old in both genders. In this age group the reported prevalence rates were 41% for men and 57% for women (Heistaro et al. 2007).

The prevalence of LBP may be higher among the older than the younger population. Many factors may contribute to this, such as the higher frequency of degenerative changes in facet joins and discs, spinal stenosis, and vertebral factures. In a systematic review of the back pain literature between 1966 and 1999, the reported prevalence figures of LBP ranged from 13% to 51% among persons aged 65 and older (Bressler et al. 1999). In a representative sample from Finland taken in 2000, the one-month prevalence of LBP increased up to the age group of 75–84 years and decreased thereafter. In that age group the reported prevalence was 41% (Riihimäki and Heliövaara 2002). However, the association between back pain and increasing age is not well established because persons aged 65 years and over are under-represented in the literature.

2.4 Recurrence and chronicity

It is believed that 60–70% of acute LBP episodes resolve themselves within 6 weeks and 80–90% within 3 months without any functional loss (Andersson 1999). However, recurrence and chronicity of LBP are common. Croft and co-workers (1999) reported an annual recurrence rate of LBP at 34% for men and 37% for women in their prospective population-based cohort study. In another prospective study by Elders and Burdorf (2004) among scaffolders, the annual recurrence rates for LBP ranged from 64% to 77% over the 3-year follow-up period. In addition, data from the Netherlands showed a recurrence rate of 57% among a working population at a one-year follow-up point (van den Heuvel et al. 2004).

Many researchers have reported that a previous episode of LBP is an important predictive factor for a new report of LBP (Croft et al. 1998; Müller et al. 1999; Thomas et al. 1999). In addition, the duration of the LBP episode, having radiating pain (van den Heuvel et al. 2004), poor general health (Croft et al. 1999) and limited physical function (Marras et al. 2007) were associated with recurrent LBP.

Long and colleagues (1996) examined the features of chronic LBP among patients aged 25–75 years old in the USA. They found that 33% reported concomitant unilateral leg pain and 27% bilateral leg pain. Weiner et al. (2006) studied the occurrence of radiating pain among persons aged 60 years and over. Of those with chronic LBP, 52% had concomitant buttock pain and 52% leg pain (Weiner et al. 2006). Furthermore, in an epidemiologic survey of adults aged 18 and over in France, 47% of persons with chronic LBP had also leg pain (Bouhassira et al. 2008).

Some reports have examined work-related factors as predictors of recurrent LBP. In the prospective studies, recurrent LBP was associated with manual handling of material (Elders and Burdorf 2004), flexion or rotation of the upper part of the body, and psychosocial factors at work (van den Heuvel et al. 2004, Marras et al. 2007). Based on the literature it seems that predictive factors for the onset and recurrence of LBP are similar.

The prevalence of chronic LBP has been a matter of controversy. In a representative sample of Finns aged 30 years or older, chronic low back syndrome was diagnosed in 11% of subjects (Heistaro 2007). The prevalence rates of chronic LBP have ranged from 20% to 48% for a period of 3 months and from 10% to 75% for a period of 12 months (Manchikanti 2000). These results were based on cross-sectional studies or short follow-up periods. Previous reports of the natural history and persistence of LBP have covered 5 years (Hestbaek et al. 2003).

Some characteristics of pain and many individual and psychosocial factors play a role in the transition from acute to chronic LBP. These include the presence of severe acute radiating LBP, a high level of disability, obesity, increasing age, being female, distress and depression (Diamond and Borenstein 2006). Also, occupational factors such as job dissatisfaction and manual handling and lifting, and low educational level, have been reported to be related to chronic LBP (Van Tulder et al. 2002).

Radiating LBP may be more chronic than non-specific LBP. Tubach et al. (2004) studied the natural course of radiating LBP among French adults. Of those with radiating LBP at baseline, after two years 55%, and after four years 53% still reported the symptom (Tubach et al. 2004).

2.5 Relationships between low back and neck pain

In a population-based study among persons aged 25 years and older, LBP was the most common and NP the second most common symptom of musculoskeletal pain in five different anatomical areas (Picavet and Schouten 2003). The 12-month prevalence rate for LBP was 44% and for NP 31%. An association between LBP and NP is expected because of the high prevalence rates for both LBP and NP and because both symptoms are located in the spine.

Recently, several cross-sectional studies have reported co-occurrence of NP with LBP. In the German population, 37% of men and 56% of women with LBP had concomitant NP (Schneider et al. 2006). Haukka et al. (2006) examined musculoskeletal symptoms in multiple body regions in female kitchen employees in Finland. The results showed that of those that had experienced LBP during the past 3 months, 83% reported coexisting NP. Also IJzelenberg and Burdorf (2004) studied musculoskeletal co-morbidity among industrial workers in the Netherlands. In that study most of the subjects were men (94%). Among the subjects with LBP, 37% had also NP. The risk of NP occurring concurrent with LBP was related to a high intensity of LBP and to a high level of disability due to LBP (IJzelenberg and Burdorf 2004).

Musculoskeletal pain in multiple body regions is common among older people as well (Picavet and Schouten 2003). Vogt and colleagues (2003) studied musculoskeletal co-morbidity connected with NP and shoulder pain among persons aged 70 to 79 years. The risk for multi-site pain increased with an increasing severity of NP (Vogt et al. 2003).

There are few prospective studies on the relationship between LBP and NP. In these studies the length of the follow up has been relatively short, varying from a few weeks up to one year. A history of LBP was associated with subsequent NP among the general population in a one- year follow up study (Croft et al. 2001). Hoving et al. (2004) studied the prognostic factors for recovery among patients who visited a general practice due to NP. Concomitant LBP was associated with poor recovery in the 7 and 52 week follow-up periods. Also, in a cohort study by Hill et al. (2004), concomitant LBP was related to persistent NP over a one-year follow–up period.

2.6 Clinical findings

In clinical practice, manual palpation of the spinal structures, the measurement of the ROM, and pain provocation tests are widely used in the examination of persons with LBP. Waddell (1992) pointed out that a clinical examination can be viewed as an objective assessment of the current functional ability of the low back in persons with LBP.

Localized tenderness in muscles or bony structures with palpation or percussion of the lumbar paravertebral area was related to chronic (Waddell et al. 1992) and severe LBP (Michel et al. 1997). Prevalence rates of abnormalities such as muscle spasm, tenderness, and trigger points in the lumbar area ranged from 58% to 88% among persons who were referred to specialists due to low back disorders (Long et al. 1996, McGregor et al. 1998a, Bejia et al. 2004). However, an association between palpable changes in muscles and LBP is unknown, due to the low reliability of the palpation measures and to a lack of common criteria for the performance of the examinations (Fryer et al. 2004, Seffinger et al. 2004).

A restricted range of active movements in the spine was observed among persons with acute LBP, and especially in those with radiating LBP (Thomas et al. 1998). Bejia et al. (2004) studied retrospectively the clinical features of persons who were referred to specialists due to nerve root pain. Of 1092 subjects, 89% had restricted spinal flexibility in active movement in the clinical tests.

Fujiwara et al. (2000) studied the association between the flexibility of the lumbar spine and degenerative changes in discs and facet joints in vitro. The decreased segmental flexibility of the spine was associated with severe degeneration in discs and facet joints. McGregor et al. (1998b) studied the associations between different grades of lumbar disc degeneration and spinal movements among 57 patients with LBP. They found no relationship between flexibility of the spine and the overall grading of degenerative disc disease (McGregor et al. 1998b).

A neurological clinical test such as the straight leg raising (SLR) test is conducted when assessing the possibility of nerve root compression. The clinical SLR tests are used to detect lumbar nerve root irritation at the levels of L4 to S1 due to herniation of the nucleus pulposus of an intervertebral disc. The SLR is positive if leg pain is elicited up to 60^0 in passive flexion of the straight leg (Deyo and Weinstein 2001). According to a systematic review, the diagnostic value of the SLR test is controversial due to large variation in the performance of the procedure (Rebain et al. 2002).

A positive SLR test result is uncommon among worker populations. Only 3% of industrial workers had a positive SLR test in physical examinations (Battié et al. 1990b). The prevalence of positive SLR test results may increase when workers with LBP are examined (Viikari-Juntura et al. 1998). Among persons who had nerve root pain, the prevalence of a positive SLR test was 54% (Bejia et al. 2004). In another study among persons who were referred to orthopaedic surgeons and neurosurgeons due to persistent LBP, 43% had a positive SLR test (Long et al. 1996).

Waddell et al. (1992) investigated a group of clinical examinations to create an index of clinical impairment in the lumbar spine that could discriminate between persons with or without ordinary LBP. The study was done among 120 chronic LBP patients with or without radiating pain and 70 asymptomatic subjects aged 20–55 years; those with nerve root pain or neurological symptoms were excluded. The authors proposed an index of clinical impairments in the low back including tests on flexion and extension, average lateral flexion measured in a standing position, average straight leg raising, spinal tenderness, bilateral active straight leg raising, and sit-ups (Waddell et al. 1992). The physical impairment index classified 78% of persons with chronic LBP and normal subjects correctly (Waddell et al. 1992). Among persons with acute LBP the correlation between the physical impairment index and a pain rating was 0.47 (Fritz and Piva 2003).

The association between an individual physical performance and future LBP is still unclear (Hamberg-van Reenen et al. 2007). Takala and Viikari-Juntura (2000) studied the predictive value of physical performance tests among a cohort comprising both non-symptomatic and symptomatic workers aged less than 54 years. Decreased flexibility of the spine was related to subsequent LBP over a two-year follow up period. On the contrary, Battié at al. (1990a) did not find an association between spinal flexibility and future severe low back complaints among industrial workers aged 21–67 years over a four-year follow-up period. Differences in measurement techniques (goniometer vs. the Schober test) and the length of the follow-up may have contributed to the differences between the above studies.

Battié et al. (1990b) examined a set of physical measurements as predictors for subsequent severe LBP among over 2000 industrial workers during a follow-up period of nearly four years. The study sample consisted of 2350 men and 670 women aged 21–67 years. Only a positive SLR test at baseline predicted future severe low back disorders in both genders (Battié et al. 1990b). Similarly, Van Nieuwenhuyse (2009) examined a pattern of physical measurements as predictors for subsequent LBP lasting seven or more consecutive days among employees (n = 692, of those 60% were women) aged 30 years or less over a one year follow-up period. The results showed that none of restricted in clinical findings at baseline was predictive factors for future LBP.

The number of symptoms or signs may reflect the severity of the condition and the ability of the person to recover from LBP. Viikari-Juntura et al. (1998)

studied the association between clinical examinations and future sick leave due to LBP among workers who were seeking care due to LBP during a two-year follow-up period. Of those who had four symptoms or signs of LBP with different combinations of symptoms, 50% to 58% had taken long-term sick leave due to LBP, while among those who had two symptoms or signs of LBP, between 19% and 39% had taken such a sick leave (Viikari-Juntura et al. 1998).

The association between clinical tests and LBP is still insufficiently understood (McGregor et al. 1998a, Tsuji et al. 2001, Evcik and Yücel 2003, Seffinger et al. 2004). Until now, most of the studies have examined the association between a single test and LBP, and the follow-up periods have been relatively short, varying from two to four years. Longer-term prospective studies on the association between clinical impairments and subsequent LBP are rare among the working population.

2.7 Health care utilization and disability

Only some people with LBP seek care from health care professionals. Walker et al. (2004) examined health care use among adults with LBP in a population-based survey in Australia. Of those with LBP, 45% sought care. In another population-based study in the United States, 39% of persons with acute LBP sought medical care (Carey et al. 1996). Most persons with LBP visited general practitioners. In Denmark, 60% of persons who had experienced LBP at some time sought care from general practitioners, 25% from medical specialists and 15% from chiropractors (Biering-Sørensen 1983).

The need to seek care depends on several pain-related factors. According to several cross-sectional studies, seeking care because of LBP was associated with pain intensity, the radiation of pain, and prolonged pain and disability (Carey et al. 1996, Linton et al. 1998, Molano et al. 2001, Mortimer et al. 2003). Also, the need to seek care was related to the number of LBP episodes, according to a large population study (Carey et al. 1996). Persons who had experienced many episodes of LBP were less likely to seek care than those with fewer episodes.

The association between gender and seeking care is unclear. In a study by Walker et al. (2004), women were twice as likely to seek care as men. On the contrary, Carey et al. (1996) did not find any relationship between gender and seeking care due to LBP. The differences in the results may be due to differences in the definition of LBP; in the study by Walker et al. (2004) LBP was defined as pain in the past 6 months and in the study be Carey et al. (1996) as functionally limiting pain lasting for less than 3 months.

Linton and colleagues (1998) studied the associations between the use of health care and self-reported work absenteeism due to LBP or NP among 3000 Swedish adults, aged 35–45 years old. In the 1-year follow-up study, a large number of visits to different health care providers (doctors, chiropractors, physiotherapists, non-traditional therapists) were related to long-term work absenteeism; in addition, a small group of persons used a large part of the health care resources. Of those with spinal pain, 6% were in charge of 41% of the health care visits (Linton et al. 1998).

Takala and Viikari-Juntura (2000) studied associations between the physical performance of the lumbar spine and medical consultations among 430 workers in the forest industry. They reported that the restriction of lumbar spine mobility was predictive of medical consultations due to LBP among men over a 2-year period. Also, in a cross-sectional study by Mortimer et al. (2003), men with restricted flexibility of the spine were about twice as likely to seek care due to LBP than those with normal spinal function.

Hospitalization due to low back disorders is quite a rare event. Leino-Arjas et al. (2002a) examined hospital admissions due to lumbar intervertebral disc disorders (LIDD) among all 25–64 year olds working in Finland in 1996. The data showed that there were 5934 cases of hospitalization due to LIDD, representing a one-year incidence of about 0.2% within the targeted population. Correspondingly, data from a national survey in the United States showed that less than 2.0% of patients who visited primary care physicians due to low back disorders were referred to hospitals (Hart et al. 1995). In addition, a Finnish primary health care study showed that of the patients with radiating LBP, 15% were referred to hospitals (Mäntyselkä 1996).

Socioeconomic and work-related factors are associated with hospitalization due to low back disorders. Low socioeconomic status, physically strenuous occupations, low job control and low supervisor support were related to hospitalization due to back disorders (Heliövaara et al. 1987, Leino-Arjas et al. 2002a and b, Kaila-Kangas et al. 2004, Leino-Arjas et al. 2004, Kaila-Kangas et al. 2006). Also, lifestyle factors such as obesity and smoking clearly increased the risk for hospitalization (Kaila-Kangas et al. 2003). However, little is known about pain-related factors and clinical findings as predictors of hospitalization due to LBP among a working population.

Long et al. (1996) examined the characteristics of patients who were referred to specialists due to LBP in the United States. Prolonged pain, radiating pain, and weakness or numbness in the legs were common. Furthermore, pain in palpation, pain in movement, restricted flexibility of the spine and a positive result in the SLR test were all frequent findings in physical examination among this patient group.

Several studies have evaluated the association between LBP and disability (Enthoven et al. 2006, Holmberg and Thelin 2006). However, only a few studies categorized LBP as local or radiating. The severity of low back symptoms (Linton et al. 1998, Elders et al. 2003) and the occurrence of radiating pain (Müller et al. 1999) were associated with work absence due to LBP, specialist consultations and the use of imaging services (Chenot et al. 2008). Furthermore, other authors have found that radiating LBP was associated with more severe and long-lasting pain and disability than local LBP (Riihimäki et al. 1989, Ren et al. 1999, Gheldof et al. 2005).

The consequences of LBP may be associated also with the distribution of radiating pain and the results of the clinical measurements. Among male industrial workers over an 18-month follow-up, those with LBP radiating below the knees had a three-fold increased risk for long-term LBP compared to those without radiating pain (Gheldof et al. 2007). In the studies of Selim et al. (1998) and BenDebba et al. (2000) chronic LBP subjects were categorized according to the Quebec Task Force spinal disorders classification with the addition of the straight leg raising test: (1) back pain alone, (2) back pain with leg pain radiating above the knee, (3) back pain with leg pain radiating below the knee, (4) back pain with leg pain radiating below the knee and with a positive SLR (Spitzer et al. 1987). The subjects whose pain radiated below the knee level and who had a positive SLR test used more health care services, had a poorer health-related quality of life, reported more severe pain, and often had other physical symptoms such as numbness, tingling or weakness in the lower extremities, dysfunction of the bowel or bladder or sleep disturbances as compared to persons with radiating LBP above the knee level or those who only suffered from local LBP (Selim et al. 1998, BenDebba et al. 2000).

Chronic LBP was associated with disability among older adults in the study by Rudy et al. (2007) and the severity and persistence of LBP has been found to increase with age (Cassidy et al. 1998, 2005). Few reports exist on the prevalence of back pain in the older population, however. Webb and colleagues (2003) studied the prevalence of spinal pain and associated disability among adults in the UK. The highest prevalence of disabling LBP and NP was in those aged 75 years and over (Webb et al. 2003).

2.8 Summary of the literature

In epidemiologic studies the occurrence of LBP is most often considered as one entity. A classification based on the anatomical distribution of symptoms to local pain and radiating pain has been seldomly used. The findings in the previous reports point out that radiating LBP may be particularly severe and prolonged. However, the existing longitudinal studies of normal population samples have been restricted to follow-ups of 1–4 years, and an exploration of the persistence and incidence of local and radiating LBP in long-term cohort studies has not been carried out.

Radiating pain seems to be associated with a greater need for healthcare services than local LBP. Few studies have examined pain-related factors as predictors of hospitalization due to LBP, however. Little is known about the associations of systematically assessed clinical findings with LBP in working population samples, or the extent to which clinical findings might predict the need for hospital care.

LBP seems frequently to coexist with NP, but how such relationships develop with ageing and whether pain in one location has a predictive value for pain in another location is not well established.

Thus, more information is needed on the long-term course of local and radiating LBP, their associations with local and radiating NP, with clinical findings in the low back, and indicators of the severity of the disorder such as hospital admissions.

3 PURPOSE OF THE STUDY

This study is a part of the METELI-study programme carried out among employees of the Valmet (today Metso) factories of the engineering industry in Jyväskylä, Central Finland. The study programme started in 1971 with the general aim to examine associations of living conditions, work, and individual characteristics with health and well-being.

The aim of the current study was to increase knowledge on the occurrence of low back disorders among the working population as it ages, and on the relationships of low back pain with clinical findings in the lumbar spine and with neck pain. Special attention was paid to possible differences between local and radiating LBP.

The specific purposes were:

1. To evaluate the persistence and incidence of LBP (study I).
2. To study the associations of LBP with NP, using both a cross-sectional and a prospective design (II)
3. To examine clinical findings in the lumbar spine associated with LBP or predicting it (study III).
4. To investigate characteristics of LBP and clinical findings in the lumbar spine as predictive factors for hospitalization due to low back disorders (study IV).

4 MATERIAL AND METHODS

4.1 Study population and sampling

All 4 750 employees registered at the Valmet factories in Jyväskylä, Central Finland, in November 1971 participated in a preliminary questionnaire survey (METELI, 1975). The preliminary questionnaire included questions about working conditions and leisure-time physical activity. The response rate was 84% for men and 90% for women. Of the respondents, 75% of the men and 79% of the women expressed a willingness to participate in a clinical examination. The study population consisted of persons who expressed such a willingness and had been employed by Valmet for at least 15 months in January 1973 (n=3934).

For the final sampling, the study population was stratified by age (those born in 1925 or earlier, those born in 1926-1945, and those born in 1946 or later), gender, and occupational class (managers, other office staff, skilled workers, semiskilled workers). In addition, the respondents were arranged within the strata in an ascending order according to their leisure-time physical activity score. In each stratum, an equally spaced (by strata) systematic, non-proportional sampling was undertaken (METELI, 1975). The non-proportionality was aimed at increasing sample size in the smaller strata. The purpose of the use of systematic sampling was to ensure that variability in physical activity was adequately captured. At the time of the health examination, there were 155 subjects (17% of the sample) who had left the employer or who refused to participate in the examination. These study participants were replaced by new persons from the list (the next person in order according to physical activity was asked to participate). The target size of the cohort was 600 men and 300 women.

The distribution of the final sample (n=902) by age, gender, and dichotomized occupational class at baseline is presented in Table 1. The particular jobs of participants varied from foundry work and heavy engineering to precision engineering and clerical and administrative tasks. The factories produced various metal products: paper machines, tractors, firearms, gauges, etc.

Altogether 232 subjects of the cohort died during the 28-year follow-up. Changes of occupational class were rare during the two first five-year follow-up periods. During the first five years the following changes occurred: among the white-collar employees, 34 retired and four changed their occupational class; among the blue-collar employees, 65 had retired and 27 had changed their occupational class. During the 2nd five-year follow-up (i.e. at the 10-year follow-up), among the white-collar employees 90 had retired and two had changed their occupational class, while the respective figures for the blue-collar workers were 137 and 24. At the end of the 1980's organizational changes occurred within the Valmet (later Metso) corporation, which lead many persons to seek new employment elsewhere. At the last examination, 66% of participants were under 65 years old and 75% of them were still in working life.

Ethical approval for the study (the last follow-up) was obtained from the Ethics Committee for Research in Occupational Health and Safety for the Hospital District of Helsinki and Uusimaa.

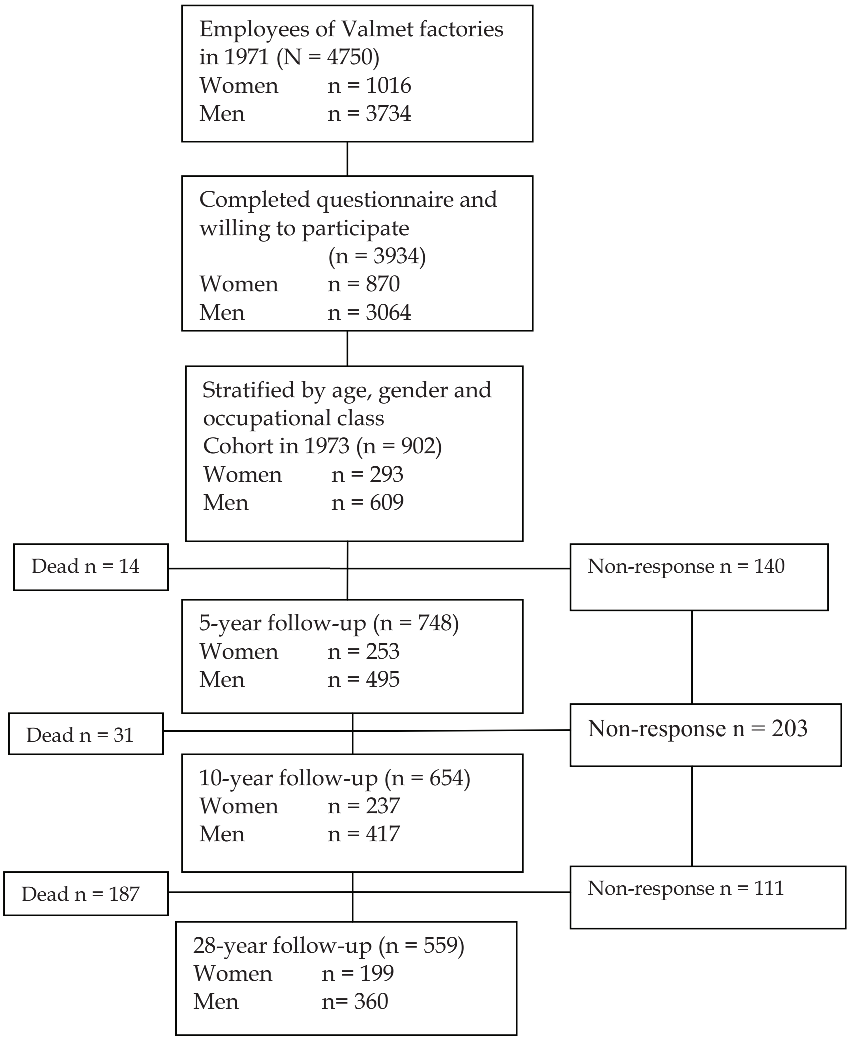

FIGURE 1 Flow chart of the study with the number of participants and dropouts in the three follow-ups.

4.2 Study design and measurements

The data were collected by questionnaires and clinical measurements. The following numbers of subjects took part in follow-up examinations: in 1978, 748 subjects (84% of the survivors); in 1983, 654 (76%); and at the turn of 2000-2001, 559 (81%), (Figure 1). The questionnaire was also sent to those who had retired during the follow-up period.

The questionnaires included items on the socioeconomic background of the subjects, working conditions, lifestyle, and health, including musculoskeletal disorders and diseases. An examination of the musculoskeletal system was included in the set of clinical measurements. The health status of the low back was assessed using several measures: location and frequency of pain, clinical findings by a physiotherapist, and disorders severe enough to lead to hospital admission. Neck pain was assessed based on its location. Figure 2 presents the main variables of the study concerning the low back and the neck.

4.2.1 Questionnaire-based information on low back disorders and neck pain

Musculoskeletal pain was assessed using the following identical question in every survey (see Appendix 1[METELI 1975]): "Have you felt an ache, stiffness, sensitivity to movement, numbness or pain in the joints or muscles of the areas listed below, and how often during the past 12 months?" This was followed by a list of twenty-five body regions, including the low back (lumbosacral area). Questions on the radiation of pain in the low back to the leg(s), separately to the left and right side were also included (radiation to the thighs or toes were given as examples). Each item was scored using the scale: 1 = never, 2 = sometimes, 3 = rather often, or 4 = often or continuously.

If the subject had responded to at least one low back related item, but left 1-2 items unanswered, the missing information was substituted by using the code 1 (= never). The total number of substitutions was low: 10 in 1973, 2 in 1978, 8 in 1983, and 21 in 2000.

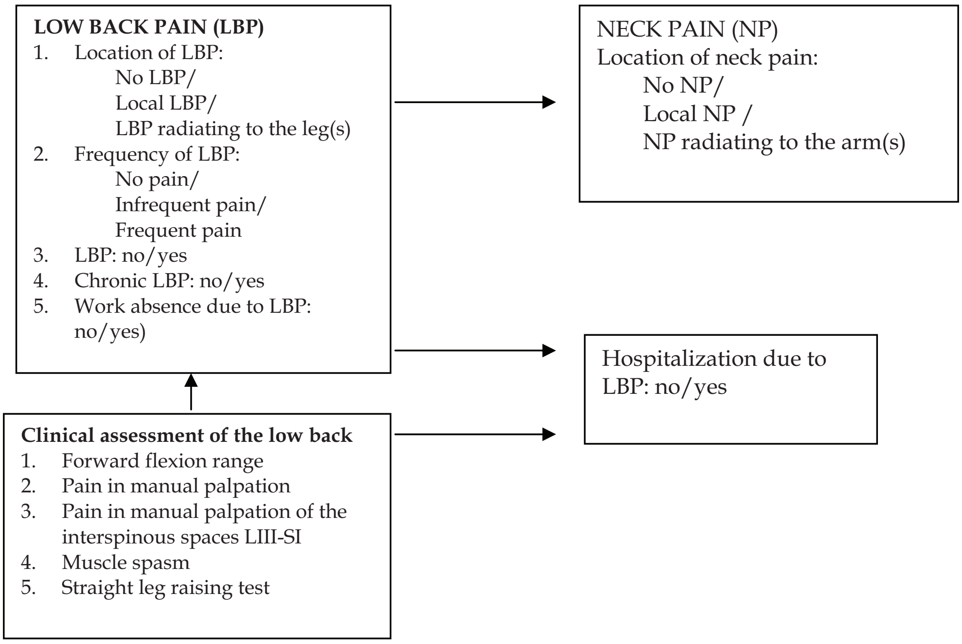

FIGURE 2 Main variables related to the low back and the neck. Arrows indicate the directions of the examined associations.

We defined LBP based on one or several variables, i.e. the item on local LBP and the two items on radiating LBP. Most subjects with radiating LBP also reported local LBP. The maximum proportion of those reporting only radiating LBP was 1.7% in the different surveys.

The following definitions of LBP were used:

1. *Question a:* Pain in the low back (LBP) (Study I)

Pain in the low back was dichotomized as no (response 1 in the item on pain in the low back) or yes (response $\geq$ 2 in the item on pain in the low back).

2. *Question b:* Radiation of LBP to the left and / or right leg(s) (Study I)

Radiation of LBP was dichotomized based on the two variables on radiation of LBP to the leg (right and left side) as no (response 1 in the two items on radiation of LBP) or yes (response $\geq$ 2 in one or both items on radiation of LBP).

3. Combination of the questions on pain in the low back (Question a) and radiation of LBP to the left and / or right leg(s)(Question b). Local and radiating LBP (Study II, Study III, Study IV)

The subjects were classified as follows: 1) *no LBP*: response 1 in all items on LBP (question a and b), 2) *local LBP*: response $\geq$ 2 in the item on pain in the low back (question a) and 1 in both items on radiation of LBP to the left and right legs (question b), and 3) *radiating LBP*: response $\geq$ 2 in the item on pain in the low back (question a) and $\geq$ 2 in one or both items on radiation of LBP (question b). Note that based on this categorization a subject in the class of local LBP did not have radiation of LBP to the left and / or right leg(s).

4. Frequency of LBP (Study IV)

The questions on the frequency of local and radiating LBP were pooled together as follows: no pain (response 1 for each item), frequent pain (response $\geq$ 3 for at least 1 item), and infrequent pain (all other combinations).

The following definition of NP was used:

Local NP and radiating NP (Study II)

Similar to the question c of LBP above, all subjects were classified as 1) *no NP*: response 1 in the three items on NP, 2) *local NP*: response $\geq$ 2 in the item on NP and 1 in both items on radiating NP, and 3) *radiating NP*: response $\geq$ 2 in the item on NP and $\geq$ 2 in one or both items on radiation of NP. A subject in the class of local NP did not have radiating NP. The maximum proportion of those with only radiating NP was 1.1% in the different surveys, i.e. the great majority of subjects with radiating NP also had local NP.

We studied persistence of LBP, local or radiating, among the subjects with LBP at baseline, by comparing their reports at the different follow-ups with that at baseline. Note that due to the recall period of 12 months at each survey, persistent pain as defined could have been either chronic (occurring continuously from the baseline to the follow-up) or recurrent (occurring at baseline and at follow-up but not necessarily in between). Incidence of pain was understood as a report of LBP at a follow-up survey among subjects without LBP at baseline.

Chronic low back disorder

The variable "chronic low back disorder" was created by combining two questions about diseases of the lumbar spine. The first question inquired: “Do you have any long-term disease or impairment?” The participant was asked to write down all diseases that she or he suffered from. Another question asked: "Have you ever had radiating LBP diagnosed by a physician?" (yes/no). Subjects who responded 'yes' to this question or reported having a disease of the lumbar spine were classified as having had a chronic low back disorder sometime during their lifetime.

Work absence due to low back pain

Work absence due to LBP was determined by pooling the answers from two questions. The first question was: "When were you last absent from work or unable to do your duties because of sickness or an injury for at least three consecutive days?" The datum (year and month) was recorded. The second question inquired: "What was the disease or ailment?" If the absence from work was due to a disease of the lumbar spine, persons were classified as taking sick leave because of low back disorders. The subjects were categorized as those with no absenteeism and those with absenteeism due to LBP.

4.2.2 Clinical examination of the low back

Measurement methods were designed in 1972 based on the guidelines of the American Academy of Orthopaedic Surgeons (1965). Three physiotherapists performed a systematic clinical examination of the musculoskeletal system (METELI, 1977). They took part in a training program tailored for the study purpose before the beginning of the study. The main aim of the training sessions was to standardize measuring technology, classification of signs, and style of reporting. In addition, the measurement design was gone through in a pilot study including 150 people beyond the study sample (Aro et al. 1980).

In the clinical examination the study participants wore their normal underwear but no shoes. Test movements were performed only once.

Forward flexion

Forward flexion was assessed after asking the subject to bend forward as far as possible, and categorized as follows: the fingertips touched the floor = 0, fingertips reached below the middle of the shin =1, and fingertips reached above the middle of the shin = 2. Due to a low number (n=4) of subjects in the last group the two latter categories were combined.

Manual palpation

Spasm and pain in the muscles of the low back region were assessed by manual palpation using fingers. In addition, pain in the interspinous spaces between LIII and S1 was assessed by palpation with the thumbs. The examinee was prone on the examination table. The subjects were asked to tell if they experienced pain or tenderness in palpation. Pain in muscles was categorized as none or slight = 0 and significant = 1. Muscle spasm was categorized as none = 0, slight = 1 and significant = 2, and pain in palpation of the interspinous spaces at each three levels separately as none = 0, slight = 1 and significant = 2.

The SLR test

The SLR test was conducted in the supine position for both legs; the right and left side were coded separately. The physiotherapist supported the person's leg at the heel, maintaining knee extension, and raised the leg to the point of pain reproduction, or up to 90 degrees. The test was considered positive if radiating pain was evoked in the leg. A goniometer was used to measure the angle at pain provocation and the degrees were recorded.

Clinical findings
Two approaches were used to consider clinical findings. An overall sum of clinical findings was calculated (study IV) based on the following eight dichotomized items (normal vs. other): forward flexion, muscle spasm, pain or tenderness in muscles, pain in the interspinous spaces (3 items), and the SLR test (2 items). The score was categorized as no abnormal findings or at least one abnormality.

In study III, five variables, pain in the interspinous spaces (3 items), and the SLR test (to the right and left separately) were entered together in the cluster analysis. After clustering, the three groups were labelled as no findings, minor and severe findings.

4.2.3 Hospitalization due to low back disorders

Information on hospital admissions due to low back disorders was drawn from the Finnish Hospital Discharge Register (now called the Health Care Register). The National Institute for Health and Welfare (before 2009, the National Research and Development Centre for Welfare and Health) maintains the register and assembles annual data from every hospital in Finland. The register covers the patients´ personal and demographic information, clinical and administrative data, and primary and subsidiary diagnoses. The register was established in the late 1960s and soon it was extended to cover all hospitals in the country. According to an evaluation in the early 1970s the register was already functioning quite well (Poikolainen, 1982).

The information from the Hospital Discharge Register is considered to be highly reliable. The register’s range of coverage is good. It has been established that about 95% of all hospital discharges are registered (Salmela and Koistinen 1987) and that the accuracy of diagnoses is high when compared with patients' records at the hospital (Keskimäki and Aro 1991). The principal sources of referral to hospital treatment are the public primary health care centres and occupational health services. Also the private health care sector may refer patients to hospitals. Of the several thousands of hospital admissions that occurred in our study cohort during the long follow-up, more than 80 % were to one hospital (the central hospital of Central Finland).

All low back -related diagnoses during the period of 1973–2000 were coded into the register according to the Finnish version of the eighth, ninth and tenth revisions of the International Classification of Diseases (ICD). Only primary diagnoses were considered. The register data from the Finnish Hospital Discharge Register were linked with the original data set using the unique personal identification code (Finnish identification system) of each study participant.

4.2.4 Covariates

Occupational class. In this study the managers and the office staff were pooled in one group (white-collar employees, n = 400) as were skilled workers and semiskilled workers (blue-collar employees, n = 502).

Body mass index (BMI, kg/m^2). In the clinical examination the study participant's body weight was measured to the accuracy of 0.1 kg, with the participant dressed in light sportswear and without shoes. Height was self-reported in the questionnaire. The subjects were categorized into two classes based on the classification of the World Health Organization: BMI < 25.0 (normal weight) and BMI ≥ 25.0 (overweight).

Smoking. Smoking was assessed using the question: “Do you smoke regularly at present? (no/yes/have stopped smoking)”. The number of cigarettes the person smoked each day was also inquired. For the purposes of the present study, the subjects were categorized as current smokers or other. One subject had missing information regarding smoking.

Distress symptoms. Distress symptoms were assessed using the question: “Have you had some of the following symptoms and how often during the past year?” Eighteen common psycho-physiological symptoms were listed (Appendix 2). The rating of each item was 1 (never), 2 (sometimes), 3 (quite often), and 4 (often or continuously). A total score was calculated (Cronbach´s alpha = 0.84) and the results were arranged using tertiles: low (≤ 22), moderate (23–28) and high levels of distress (≥ 29). The validity of the distress symptoms score has been discussed elsewhere (Aro 1981, Leino 1989).

4.2.5 Mortality data

Mortality data were collected from the Statistics Finland national mortality register using the participants’ personal identification codes.

4.3 Statistical analyses

Study I

Cross-tabulation was used to analyze the persistence of LBP and radiating LBP reported at baseline and follow-up visits. The analyses were made for the total material as well as for those who participated in all three follow-ups (n=418). In addition, stratified analyses by gender and occupational class were made.

The interdependence of the occurrence of LBP at baseline and at the follow-up surveys was analyzed using logistic regression with the categorical covariates age, gender, and occupational class. The analyses were done for LBP and radiating LBP separately. SPSS 10.1 statistical software was used.

Study II

In describing associations between the type of LBP and the type of NP at baseline, the Cox proportional hazards model with equal times of follow up was used to obtain prevalence ratios (Thompson et al. 1998). This was done to avoid undue inflation (by logistic regression) of estimates in studying associations between the common symptoms. The prevalence ratios and their 95% confidence intervals were adjusted for age group, gender and occupational class. Also, analyses stratified for gender (adjusted for age and occupational class) and occupational class (adjusted for age and gender) were made.

The Cox proportional hazards model was also used to analyze associations between LBP (non-existent/local/radiating) at baseline and radiating NP at the 5-, 10-, and 28-year follow- up examinations, among those without radiating NP at baseline. Relative risks and 95% confidence intervals adjusted for age group, gender and occupational class were calculated and analyses were stratified as above. Analyses were performed using the SPSS, version 12.01.

Study III

Two-step cluster analysis (Everitt et al. 2001) was used to create groups of subjects who would be as similar as possible regarding the following five variables: pain at the interspinous spaces L3–L4, L4–L5, and L5–S1, and the SLR tests (right and left side). The number of clusters was set to three before the procedure. A variable based on the cluster allocations was created. Logistic regression analysis was used to obtain odds ratios for describing the associations of the cluster variable and limited forward flexion, with local and radiating LBP at baseline. We also analyzed prospectively the associations of the cluster variable and limited forward flexion at baseline with the incidence of local and radiating LBP over the 5, 10-, and 28-year follow-ups. The odds ratios (OR) and their 95% confidence intervals (95% CI) were adjusted for age group, gender, and occupational class. The SPSS 15.0 statistical software was used.

Study IV

Logistic regression was used to analyse, at baseline, the associations of LBP, work absenteeism, and chronic low back disorders with the clinical findings in the low back. The Cox proportional hazards model was used to analyse associations between baseline characteristics and the first hospital admissions due to a low back disorder during the follow-up. Hazard rate ratios (HRR) with 95% confidence intervals were calculated to estimate the risk of hospital admission. First, the HRRs were adjusted for age, sex and occupational class, and second, an additional adjustment for BMI and smoking was made. Finally, the distress symptoms score was also considered as a covariate. The SPSS 10.1 statistical software was used.

5 RESULTS

Table 1 shows the characteristics of the cohort by occupational class, gender, and age-group at baseline. Of the sample, 32.5% were women and 67.5% were men. The proportion of the blue-collar workers was slightly higher than that of the white-collar employees: of the women, 42.5%, and of the men, 48.5%, belonged to the white-collar group (Table 1).

Figure 3 shows the prevalence of local LBP and Figure 4 the prevalence of radiating LBP at every follow-up. The prevalence of radiating LBP, but not that of local LBP increased with age.

The loss in follow-ups is described in Table 2 by gender and occupational class, and by age and the occurrence of local and radiating LBP at baseline. The loss was more common among blue-collar than white-collar employees in both genders. In addition, there were some differences in participation according to radiating LBP in the follow-ups among blue-collar employees: radiating LBP was more common among men who did not participate in the 5-, 10-, and 28-year year follow-ups compared to those who did. This association was also found among white-collar men in the 28-year follow-up. Among women, similar differences were not observed.

5.1 Persistence and incidence of low back pain (Study I)

At baseline, 54 % reported LBP (Question a) and 25 % radiation of LBP to the leg(s) (Question b) and 29 % reported local LBP during the past 12 months. The prevalence of LBP was 60% in the blue-collar workers and 45 % in the white-collar employees, while 30 % of the former and 19 % of the latter reported radiation of LBP to the leg(s). The figures also differed somewhat by gender both in LBP (women: 57 %, men: 52 %) and radiation of LBP to the leg(s) (women: 30 %, men: 23%).

TABLE 1 Distribution of the sample by occupational class, gender, and age-group at baseline.

	Total n (%)	White–collar n (%)	Blue–collar n (%)
Total	902	400 (44.3)	502 (55.7)
Women	293 (32.5)	142 (35.5)	151 (30.1)
Men	609 (67.5)	258 (64.5)	351 (69.9)
Age			
17–27 yr	250 (27.7)	103 (25.8)	147 (29.3)
28–47 yr	353 (39.1)	175 (43.8)	178 (35.5)
48–65 yr	299 (33.1)	122 (30.5)	177 (35.3)

5.1.1 Persistence of LBP

Question a: *Pain in the low back*
The persistence of LBP was high. Of those with LBP at baseline, 75%, 73%, and 88% reported similar symptoms at the 5-, 10-, and 28-year follow-up surveys, respectively.

Question b: *Radiation of LBP to the left and / or right leg(s)*
Similarly, radiation of LBP to the leg(s) was a persistent symptom. Of those with radiation of LBP to the leg(s) at baseline, 66%, 65%, and 69% were symptomatic 5, 10, or 28 years later.

Local LBP
When subjects with only local LBP (that is, when cases of combined local and radiating LBP were excluded from this category) were considered the respective figures for persistence were 45%, 38%, and 33%.

Pain in the low back (Question a) and radiation of LBP to the leg(s) (Question b) were persistent to a similar degree among women and men. Persistence was somewhat higher among blue-collar workers than among white-collar employees. For example, among blue-collar workers with radiation of LBP to the leg(s) at baseline, around 70% reported similar symptoms at each follow-up examination, while the figure for white-collar employees was 60%.

TABLE 2 Loss of subjects during the follow-up period, by gender and occupational class. The mean age (standard deviation [SD], and proportions of subjects with local and radiating low back pain (LBP) at baseline, among the participants and those lost to follow-up).

	1973 (n=902)	5-year follow-up (n=748)		10-year follow-up (n=654)		28-year follow-up (n=559)	
	Sample	Participants	Loss compared to baseline	Participants	Loss compared to baseline	Participants	Loss compared to baseline
MEN (n = 609)							
White-collar n (%)	***258 (42.4)***	***192 (74.4)***	***66 (25.6)***	***181 (70.2)***	***77 (29.8)***	***164 (63.6)***	***94 (36.4)***
Age / mean (SD)	39.8 (12.1)	44.8 (12.1)	44.7 (12.1)	49.5 (11.8)	50.4 (12.9)	62.5 (9.8)	74.2 (12.1)
Local LBP/ (yes), n (%)	70 (27.1)	53 (27.6)	17 (25.8)	50 (27.6)	20 (26.0)	47 (28.7)	23 (24.5)
Radiating LBP / (yes), n (%)	43 (16.7)	32 (16.7)	11 (16.7)	30 (16.6)	13 (16.9)	24 (14.6)	19 (20.2)
Blue-collar n (%)	***351 (57.6)***	***303 (86.3)***	***48 (13.7)***	***236 (67.2)***	***115 (32.8)***	***196 (55.8)***	***155 (44.2)***
Age / mean (SD)	38.4 (13.3)	43.0 (13.1)	45.6 (14.9)	47.0 (12.9)	51.1 (13.8)	59.0 (9.7)	73.4 (13.0)
Local LBP / (yes), n (%)	116 (33.0)	102 (33.7)	14 (29.2)	80 (33.9)	36 (31.3)	73 (37.2)	43 (27.7)
Radiating LBP / (yes), n (%)	94 (26.8)	79 (26.1)	15 (31.3)	58 (24.6)	36 (31.3)	40 (20.4)	54 (34.8)
WOMEN (n = 293)							
White-collar n (%)	***142 (48.5)***	***124 (87.3)***	***18 (12.7)***	***118 (83.1)***	***24 (16.9)***	***103 (72.5)***	***39 (27.5)***
Age / mean (SD)	37.0 (12.0)	42.7 (12.0)	37.5 (11.4)	47.8 (12.0)	43.2 (11.4)	62.8 (10.9)	67.1 (14.2)
Local LBP / (yes), n (%)	39 (27.5)	35 (28.2)	4 (22.2)	34 (28.8)	5 (20.8)	29 (28.2)	10 (25.6)
Radiating LBP / (yes), n (%)	33 (23.2)	31 (25.0)	2 (11.1)	29 (24.6)	4 (16.7)	25 (24.3)	8 (20.5)
Blue-collar n (%)	***151 (51.5)***	***129 (85.4)***	***22 (14.6)***	***119 (78.8)***	***32 (21.2)***	***96 (63.6)***	***55 (36.4)***
Age / mean (SD)	41.2 (12.6)	47.2 (12.2)	40.2 (13.1)	53.0 (11.7)	44.8 (13.7)	66.1 (11.5)	71.8 (13.8)
Local LBP / (yes), n (%)	41 (27.2)	35 (27.1)	6 (27.3)	32 (26.9)	9 (28.1)	26 (27.1)	15 (27.3)
Radiating LBP / (yes), n (%)	55 (36.4)	47 (36.4)	8 (36.4)	44 (37.0)	11 (34.4)	36 (37.5)	19 (34.5)

*One subject with missing information
†Two subjects with missing information

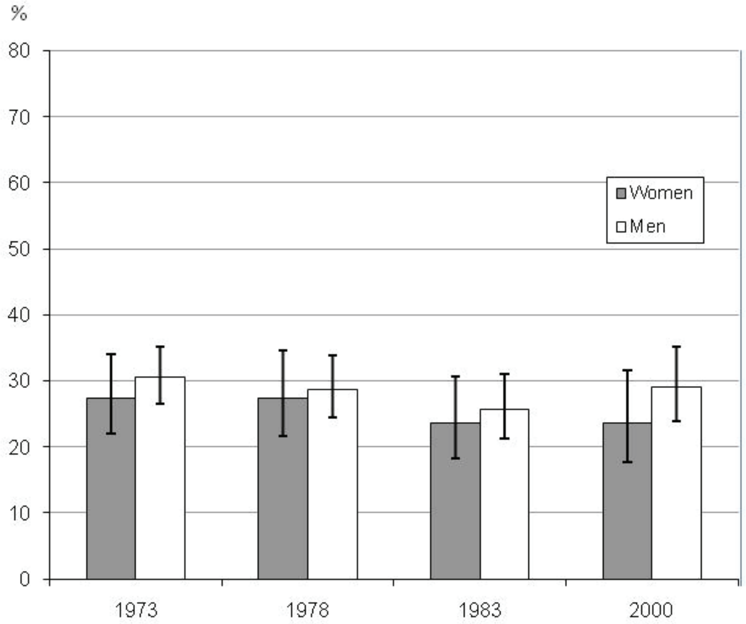

FIGURE 3 Prevalence of local LBP by gender in 1973, 1978, 1983 and 2000 with 95 % confidence intervals.

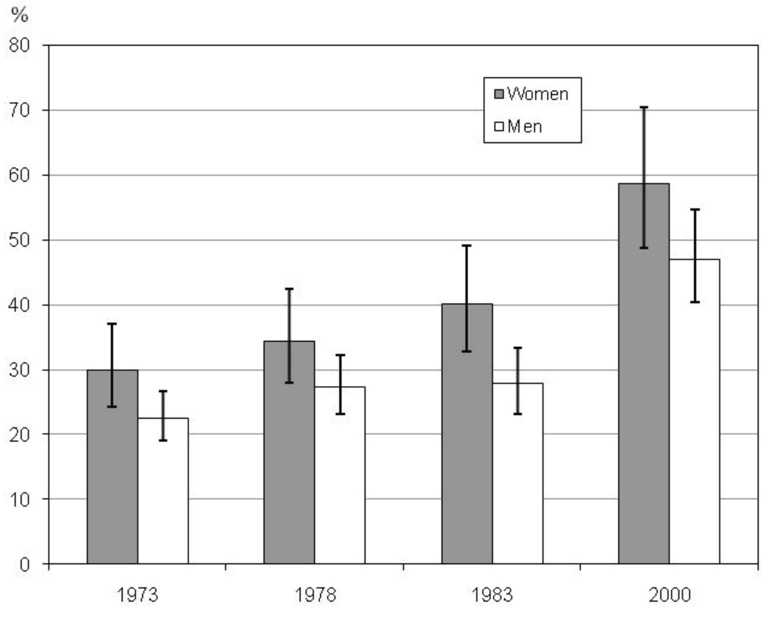

FIGURE 4 Prevalence of radiating LBP by gender in 1973, 1978, 1983 and 2000 with 95 % confidence intervals.

5.1.2 Incident LBP

Question a: *Pain in the low back*
The number of new reports of LBP increased during the follow-up, especially towards the end of the total period (Table 3a). Of those without LBP at baseline, 33%, 37%, and 64% reported such pain at the 5-, 10-, and 28-year follow-up, respectively.

Question b: *Radiation of LBP to the left and / or right leg(s)*
Also, the number of new reports of radiation of LBP to the leg(s) increased during the follow-up (Table 3a). The proportions of new reports of LBP were higher than those of radiation of LBP to the leg(s) at every follow-up. Of those without radiation of LBP to the leg(s) at baseline, 17%, 22% and 46% reported radiation of LBP to the leg(s) at the 5-, 10-, and 28-year follow-up, respectively.

Local LBP
The number of new reports of local LBP remained at the same level during the follow-up periods. Of those without local LBP at baseline, 22%, 21%, and 26% reported such pain at the 5-, 10-, and 28-year follow-up, respectively.

There were differences in the incidence rates of LBP between genders (Table 4). Women had a higher rate of LBP and radiation of LBP to the leg(s) than men in every follow-up. The clearest difference was observed for radiation of LBP to the leg(s). Among women without radiation of LBP to the leg(s) at baseline, 22%, 26%, and 57% reported pain at the 5-, 10-, and 28-year follow-up examinations. For men, the figures were 15%, 19%, and 41%, respectively.

There were also some differences between occupational classes in the incidence rate (Table 5). Blue-collar employees had new reports of radiation of LBP to the leg(s) more often than white-collar employees at every follow-up. In the last survey, among those without radiation of LBP to the leg(s) at baseline, 53% of blue-collar employees, and 40% of white-collar employees had radiation of LBP to the leg(s).

5.1.3 Multivariable analyses on the persistence of LBP

The results of multivariable logistic regression showed that the risk for persistent pain was higher among persons with radiation of LBP to the leg(s) than among persons with LBP at the 5- and 10-year follow-ups. At the last follow-up the situation was reversed. At the 5-, 10-, and 28-year follow-up examinations the ORs for radiation of LBP to the leg(s) were 8.5 (5.7–12.5), 6.7 (4.4–10.1), and 2.3 (1.5–3.6), respectively, when adjusted for age, gender and occupational class. The corresponding figures for LBP were 6.0 (95% CI; 4.3–8.3), 4.7 (3.3–6.6), and 4.0 (2.6–6.3). (see the original publication I; Table 4).

When only local LBP was studied, the associations remained stable at all follow-ups: the ORs were 4.3 (2.9–6.5), 3.9 (2.5–6.1), and 3.8 (2.0–7.1) after adjustments for age, gender and occupational class.

TABLE 3a Occurrence of pain in the low back (LBP) and radiation of LBP (to the left and / or right legs) over time, by occurrence of type of pain at baseline.

	LBP in 1978			**LBP in 1983**			**LBP in 2000**		
	Yes	**No**	**Total**	**Yes**	**No**	**Total**	**Yes**	**No**	**Total**
	%	**%**	**n**	**%**	**%**	**n**	**%**	**%**	**n**
LBP in 1973									
Yes (n = 483)	75.4	24.6	410	72.8	27.2	353	88.2	11.8	288
No (n = 419)	32.8	67.2	338	36.9	63.1	301	64.3	35.7	258
	Radiation of LBP in 1978			**Radiation of LBP in 1983**			**Radiation of LBP in 2000**		
	Yes	**No**	**Total**	**Yes**	**No**	**Total**	**Yes**	**No**	**Total**
	%	**%**	**n**	**%**	**%**	**n**	**%**	**%**	**n**
Radiation of LBP in 1973									
Yes (n = 225)	66.1	33.9	189	65.2	34.8	161	68.6	31.4	121
No (n = 677)	17.2	82.8	557	21.5	78.5	493	46.1	53.9	425

TABLE 3b Occurrence of pain in the low back (LBP) and radiation of LBP (to the left and / or right legs) over time among those who responded to all four surveys.

	LBP in 1978		LBP in 1983		LBP in 2000	
	Yes	**No**	**Yes**	**No**	**Yes**	**No**
	%	%	%	%	%	%
LBP in 1973						
Yes (n = 227)	74.9	25.1	74.4	25.6	88.1	11.9
No (n =191)	33.5	66.5	38.7	61.3	64.4	35.6
	Radiation of LBP in 1978		**Radiation of LBP in 1983**		**Radiation of LBP in 2000**	
	Yes	**No**	**Yes**	**No**	**Yes**	**No**
	%	%	%	%	%	%
Radiation of LBP in 1973						
Yes (n = 98)	62.2	37.8	65.3	34.7	72.4	27.6
No (n = 319)	16.6	83.4	22.9	77.1	46.7	53.3

TABLE 4 Occurrence of pain in the low back (LBP) and radiation of LBP (to the left and / or right legs) over time, by occurrence of LBP at baseline and gender.

WOMEN	**LBP in 1978**			**LBP in 1983**			**LBP in 2000**		
	Yes %	**No %**	**Total n**	**Yes %**	**No %**	**Total n**	**Yes %**	**No %**	**Total n**
LBP in 1973									
Yes (n = 167)	76.4	23.6	148	75.5	24.5	139	89.3	10.7	112
No (n = 126)	34.3	65.7	105	42.9	57.1	98	68.4	31.6	79
	Radiation of LBP in 1978			**Radiation of LBP in 1983**			**Radiation of LBP in 2000**		
	Yes %	**No %**	**Total n**	**Yes %**	**No %**	**Total n**	**Yes %**	**No %**	**Total n**
Radiation of LBP in 1973									
Yes (n = 88)	61.5	38.5	78	71.2	28.8	73	62.7	37.3	59
No (n = 205)	22.3	77.7	175	26.2	73.8	164	56.8	43.2	132
MEN	**LBP in 1978**			**LBP in 1983**			**LBP in 2000**		
	Yes %	**No %**	**Total n**	**Yes %**	**No %**	**Total n**	**Yes %**	**No %**	**Total n**
LBP in 1973									
Yes (n = 316)	74.8	25.2	262	71.0	29.0	214	87.5	12.5	176
No (n = 293)	32.2	67.8	233	34.0	66.0	203	62.6	37.4	179
	Radiation of LBP in 1978			**Radiation of LBP in 1983**			**Radiation of LBP in 2000**		
	Yes %	**No %**	**Total n**	**Yes %**	**No %**	**Total n**	**Yes %**	**No %**	**Total n**
Radiation of LBP in 1973									
Yes (n = 137)	69.4	30.6	111	60.2	39.8	88	74.2	25.8	62
No (n = 472)	14.9	85.1	382	19.1	80.9	329	41.3	58.7	293

Number of participants by gender:
Women: in 1978 n=253; in 1983 n=237; in 2000 n=191.
Men: in 1978 n=495; in 1983 n=417; in 2000 n=355.

TABLE 5 Occurrence of pain in the low back (LBP) and radiation of LBP (to the left and / or right legs) over time, by occurrence of LBP at baseline and occupational class.

WHITE-COLLAR	**LBP in 1978**			**LBP in 1983**			**LBP in 2000**		
	Yes %	**No** %	**Total** n	**Yes** %	**No** %	**Total** n	**Yes** %	**No** %	**Total** n
LBP in 1973									
Yes (n = 181)	70.5	29.5	149	73.6	26.4	140	84.2	15.8	120
No (n = 219)	30.5	69.5	167	37.1	62.9	159	62.5	37.5	144
	Radiation of LBP in 1978			**Radiation of LBP in 1983**			**Radiation of LBP in 2000**		
	Yes %	**No** %	**Total** n	**Yes** %	**No** %	**Total** n	**Yes** %	**No** %	**Total** n
Radiation of LBP in 1973									
Yes (n = 76)	57.1	42.9	63	62.7	37.3	59	61.2	38.8	49
No (n = 324)	10.7	89.3	252	17.5	82.5	240	39.5	60.5	215
BLUE-COLLAR	**LBP in 1978**			**LBP in 1983**			**LBP in 2000**		
	Yes %	**No** %	**Total** n	**Yes** %	**No** %	**Total** n	**Yes** %	**No** %	**Total** n
LBP in 1973									
Yes (n = 302)	78.2	21.8	261	72.3	27.7	213	91.1	8.9	168
No (n = 200)	35.1	64.9	171	36.6	63.4	142	66.7	33.3	114
	Radiation of LBP in 1978			**Radiation of LBP in 1983**			**Radiation of LBP in 2000**		
	Yes %	**No** %	**Total** n	**Yes** %	**No** %	**Total** n	**Yes** %	**No** %	**Total** n
Radiation of LBP in 1973									
Yes (n = 149)	70.6	29.4	126	66.7	33.3	102	73.6	26.4	72
No (n = 353)	22.6	77.4	305	25.3	74.7	253	52.9	47.1	210

Number of participants by occupational class:
White-collar: in 1978 n=315; in 1983 n=299; in 2000 n=264
Blue-collar: in 1978 n=431; in 1983 n=355; in 2000 n=282

5.2 Associations of low back pain with neck pain (Study II)

5.2.1 Cross-sectional analyses

When comparing the occurrence of LBP and NP at baseline, it was found that the prevalence of local pain at these sites was of a similar magnitude (30% for local LBP and 32% for local NP), but that the prevalence of radiating LBP was somewhat higher (25%) than that of radiating NP (19%).

Co-occurrence of LBP and NP was common: of those reporting some form of LBP, 65% also reported NP. When adjusted for age, gender and occupational class, those with local or radiating LBP had at baseline a roughly two-fold risk of local NP compared with those who did not report LBP (II; Table 2). These relationships remained stable at all follow-ups.

The PR of radiating NP for local LBP was 1.5 at baseline and around two at every follow-up assessment, after adjustment for age, gender and occupational class. Radiating pain at the two sites co-occurred even more closely, as the adjusted PR of radiating NP for radiating LBP was above three at every survey.

There were some differences in risk according to gender. The association of radiating LBP with radiating NP was stronger among men than women. At baseline the PR of radiating NP for radiating LBP was 2.1 (1.3–3.4) for women and 5.0 (2.9–8.6) for men, when adjusted for age and occupational class. In the final survey, radiating LBP was related to radiating NP with a PR of 5.0 (2.6–9.5) only among men.

5.2.2 Prospective analyses

Having LBP at baseline predicted new reports of radiating NP at the 5- and 10-year follow-ups among subjects without such pain at baseline (II; Table 3). Compared to those with no LBP at baseline, those with local or radiating LBP had a 2.5-fold risk of radiating NP at the 5-year follow-up, when adjusted for age, gender and occupational class. At the 10-year follow-up, the adjusted relative risk of a new report of radiating NP was 2.3 for radiating LBP and 1.7 for local LBP at baseline. At the 28-year follow-up survey these associations were so attenuated that they became statistically non-significant.

Again, there were some differences in risk by gender. The risk of incident radiating NP for those with radiating LBP at baseline was particularly clear among men (RR 4.0; 1.8-8.8). At the 5-year follow-up, the risk of radiating NP risk for local LBP at baseline was also high (fully adjusted RR 3.6; 1.8–7.1) in men. No systematic differences in the associations of LBP with subsequent radiating NP by occupational class were observed.

5.3 Clinical findings and pain in the low back (Studies III and IV)

5.3.1 Cross-sectional analyses

In study IV, the association of having at least one abnormal clinical finding of eight with various measures of LBP (any LBP, frequency and type of LBP, and the subject's report of a chronic low back disorder and of work absenteeism due to LBP) was analysed by logistic regression. Having clinical findings was associated with all indicators of LBP (IV, Table 2). Strong associations were observed with frequent LBP (OR 5.5, 95% CI 3.2-9.5) and radiating LBP (4.7; 2.8-8.0), allowing for age, gender, and occupational class. After further adjustment for BMI, smoking, and stress symptoms, these odds ratios were attenuated to 4.5 (2.6-7.9) and 3.8 (2.2-6.6). Having clinical findings roughly doubled the risk of infrequent and local LBP, self-reported chronic low back disorders, as well as of work absenteeism due to LBP, as compared with no clinical findings, after all adjustments.

In study III, clusters were created based on palpation tenderness at the three lumbar interspinous spaces and the SLR tests. To distinguish the clusters, the following descriptive labels were used: no clinical findings (cluster 1, n = 501; 55.6% of the subjects at baseline); minor clinical findings (cluster 2, n = 180; 20.0%), and severe clinical findings (cluster 3, n = 220; 24.4%). Cluster 2 included subjects with minor palpation tenderness at L5–S1, but no tenderness at the other levels. Cluster 3 included all subjects who had clear palpation tenderness of the interspinous spaces, the rest of the subjects who had minor tenderness at the interspinous spaces, and all those who had a positive SLR test.

The cluster of minor clinical findings (cluster 2) involved nearly 20.0 % of both women and men, and white-collar and blue-collar employees. The cluster of severe clinical findings (cluster 3) involved 30.0% of women, 22.0% of men and 21.0% of blue-collar employees and 27.0% of white-collar employees.

At baseline, limited forward flexion was uncommon among employees; only 3.3% of the youngest age-group, 3.7% of the middle age-group, and 9.3% of the oldest age-group and 0.7 % of women and 7.7% of men had limited forward flexion.

Both limited forward flexion and the cluster of clinical findings were clearly associated with radiating LBP at baseline after adjustment for age, gender, and occupational class (III, Table 3). The ORs were 3.1 (1.5–6.6) for limited forward flexion, 3.2 (2.1–5.1) for the cluster of minor clinical findings and 5.1 (3.4–7.8) for severe clinical findings. Associations were also observed in the clinical findings cluster variable regarding local LBP, the ORs were 1.9 (1.3–2.8) for minor clinical findings and 2.0 (1.3–3.1) for severe clinical findings.

5.3.2 Prospective analyses

In prospective analyses among subjects without radiating LBP at baseline, the clinical findings cluster variable at baseline was associated with new reports of radiating LBP at the 5-, 10-, and the 28-year follow-ups (III, Table 4). Compared to those with no clinical findings, the ORs for those with minor clinical findings were 2.7 (1.4–5.1) at the 5-year follow-up, 1.1 (0.6–2.0) at the 10-year follow-up, and 1.2 (0.6–2.3) at the 28-year follow-up, after adjustment for age, gender and occupational class. The respective figures for those with severe clinical findings were 3.8 (2.0–6.9), 1.9 (1.0–3.7), and 1.9 (0.9–3.9).

No association of limited forward flexion at baseline with new reports of radiating LBP at any follow-up was observed.

To examine predictors of local LBP, a final analysis was made among subjects with no LBP (neither local nor radiating) at baseline (n = 334). Severe clinical findings predicted new reports of local LBP with the OR of 4.15 (1.92–8.97) at the 10-year follow-up, adjusted for age, gender, and occupational class. No other associations were observed.

5.4 Hospitalization due to low back disorders (Study IV)

In the period from 1973 to 2000, 51 persons were hospitalized for low back disorders (27 women and 24 men). Hospital admissions were more common among blue-collar workers than among white-collar workers. Of those hospitalized, 51% had a diagnosis of a disc-related disorder.

Men had a lower risk of hospital admission due to a low back disorder than women (IV, Table 3): the age-adjusted hazard rate ratio (HRR) of hospitalization for men was 0.46 (0.26-0.79). Blue-collar workers were in an increased risk (2.3; 1.2-4.2) compared with the white-collar group.

In the final model those with radiating LBP at baseline were at a higher risk for hospitalization due to a low back disorder than those with local LBP (IV, Figure 1B and Table 4). The hazard rate ratio (HRR) for local pain was 2.1 (1.0–4.6) and for radiating pain 3.7 (1.8–7.7), when adjusted for age, gender and occupational class.

Those with frequent LBP at baseline had only a slightly higher risk of being admitted to hospital than those with infrequent LBP (IV, Figure 1A and Table 4). The fully adjusted HRR for frequent LBP was 3.0 (1.4–6.5) and for infrequent 2.7 (1.3–5.5). Furthermore, a self-reported chronic low back disorder predicted hospitalization with an HRR of 2.8 (1.5–5.4) when adjusted similarly. Also work absence due to low back pain was predictive of hospital admission due to a low back disorder, with the HRR of 3.3 (1.6-6.7), allowing for age, gender and occupational class.

Abnormality in the clinical status of the lumbar spine at baseline predicted subsequent hospitalization (IV, Figure 1C). Compared to those with a normal clinical status at baseline, those with some abnormality had a risk of HRR 2.4 (1.4–4.7), when adjusted for age, gender and occupational class.

We also found that being overweight doubled the risk of hospitalization due to a low back disorder (IV, Table 3), while the HRR for smoking was 1.7 (1.0-3.0). Stress symptoms were clearly predictive of hospitalization, with the HRR of 2.6 (1.0-6.4) for a medium frequency and 3.7 (1.5-9.1) for a high frequency of stress symptoms.

When further adjusted for body mass index, smoking and stress symptoms, the risk for hospital admission was 3.0 for those with radiating LBP, and 2.5 for those with LBP irrespective of LBP frequency compared to those without LBP; local LBP was of borderline significance.

6 DISCUSSION

The aim of this study was to obtain new knowledge of the long-term consequences of low back pain over a period of almost three decades. The results support the view that low back pain is very common, and often chronic or recurrent, and show that a history of pain in working-age predicts future symptoms considerably later in life. It was also shown that severe clinical findings in the low back predict new reports of, particularly, radiating low back pain.

There was a clear association between pain in the low back and that in the neck, and the association accentuated when considering radiating pain in both locations. Among subjects without radiating neck pain, both types of low back pain predicted incident radiating neck pain.

Hospitalization due to a low back disorder was a relatively rare event among the cohort, with 5.7 % of the subjects being admitted to hospital during the follow-up of 28 years. Yet it was possible to predict such admissions by self-reported low back pain. Frequent and radiating symptoms and clinical findings in the low back, as well as back-related absenteeism from work were predictors of severe back disorders requiring hospital care.

There are several methodological questions and shortcomings that must be taken into account when evaluating these findings.

6.1 Methodological considerations

6.1.1 Study population and participation rates

The study sample consisted of industrial employees including both women and men aged between 17 and 65 years at baseline. The participants´ work tasks covered all types of jobs in the engineering industry. In this study the employees were divided into two broad occupational classes, white-collar and blue-collar employees. The classification was based on occupational title and salary (METELI 1975). Obviously, this classification can more be viewed as a measure of socioeconomic position than as an indicator of exposure to physical labour or other work-related factors, although various occupational risks such as physical loading, static work phases and repetitive tasks did vary according to occupational class (Leino et al. 1988).

Transfer from one occupational class to another was rare during the follow-up, and in most cases the transfer was from blue-collar to white-collar occupations. However, work tasks and physical workload may have changed during the follow-up due to a general development of work and working methods; computer-based work increased (Lehto and Sutela 2008), and due to this and the changes in the distribution of the workforce by industry (Työministeriö 2005), tasks including heavy physical loading may have become less common. Further, knowledge of occupational health hazards has increased and ergonomics in the workplace has been improved. These general changes at work may have influenced the occurrence of LBP and NP in our cohort and weakened the effect of occupational class on pain during follow-up. These changes should not, however, materially influence our results, as occupational class was used only as a covariate or a basis for stratification of analyses.

Mortality data were collected from the Statistics Finland national mortality register. Naturally, the number of deaths was higher among the older age groups than the younger ones. Other non-participation was relatively limited and the participation rates among the survivors remained good (84%, 76% and 81% at the 5, 10 and 28-year follow-ups, respectively).

It is obvious that the loss of subjects was quite significant due to the lengthy duration of the follow-up. In addition, there were some differences in participation between the genders and occupational classes in the follow-ups. The loss of women was smaller than the loss of men in every survey. The participation rates were higher among white-collar employees than among blue-collar employees at the 10 and 28-year follow-ups. However, when persistence and the incidence of LBP was examined, a high similarity in the results was observed when comparing estimates in the sub-group that participated in all four surveys with those obtained when using all available data from each survey (Table 3b). This would imply that the composition of the cohort due to loss did not change much regarding the factors relevant for the reporting of LBP.

6.1.2 Pain assessment

The participants were asked, by questionnaire, about pain in the low back and the neck during the past 12 months at every survey. Due to the time-scale of the recall period, pain episodes that occurred beyond this time window remained unknown. Pain occurs intermittently and episodically, especially during the initial stage of discomfort (Von Korff 1994, Croft et al. 1998). In addition, the questionnaire did not include questions on LBP during childhood and adolescence. LBP is quite common and recurrent already among children and adolescents (Vikat et al. 2000, El-Metwally et al. 2004, Jones and Macfarlane 2005). For these reasons the assessment of the true incidence of LBP among adults is seldom feasible. The figures obtained in the current study are only rough estimates of the incidence or persistence of LBP or NP.

In our study, pain, stiffness, soreness and numbness of joints were included in the questions about spinal discomfort. In addition, we considered local and radiating spinal symptoms separately. In a study by Dawson et al. (2002), recall accuracy was highest for queries on radicular complaints of numbness, and the location of LBP among those with persistent LBP at baseline over a 10-year follow-up period.

In most cases of back pain the pathophysiologic source of back pain is unknown (Waddell 2004). In epidemiological studies of back-related disorders, the outcome variable is very often designed in terms of pain. According to the traditional definition of pain as developed by the International Association for the Study of Pain "Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage" (Merskey 1986). Since pain perception is multidimensional by nature and consists of physiologic, sensory, affective, cognitive, behavioural, and sociocultural aspects, its measurement is challenging.

Some factors, such as recall periods, severity and duration of symptoms and present levels of pain may affect the reliability of LBP reporting (Von Korff et al. 2000, Miranda et al. 2006). In epidemiological studies using survey methods, recall periods have varied, among the most often-used being one month, and one year. According to several studies, retrospective reporting of pain is inaccurate (Bolton 1999, Von Korff et al. 2000, Dawson et al. 2002, Miranda et al. 2006). However, in a study by Brauer et al. (2003), recalling the prior severity of pain or discomfort was accurate at least for a period of three months among employees. In the present study, questions about LBP and NP concerned the prior 12 months. This was considered as the maximum period that could be assessed with sufficient reliability, even if the follow-up intervals were longer. Further, some individual characteristics like gender and negative emotions may influence accuracy in reports of pain (Jamison et al. 1989, McGorry et al. 1999, Gedney and Logan 2004). Our analyses were always controlled for gender. In the study of predictors of back-related hospitalization (IV), allowing for distress symptoms attenuated but did not abolish associations with LBP.

The distribution of the pain frequency variables were highly skewed with a small minority of subjects reporting LBP or NP often or continuously. A limitation of the present study is that information on the frequency of pain was not used to its full potential. Here we concentrated on the location of pain (local or radiating), and examined the frequency of any LBP as a predictor of back-related hospitalization.

6.1.3 Clinical examination

At the beginning of our study in 1973 examination methods for the assessment of the overall functional ability of the musculoskeletal system were not available. The researchers (lead by prof. Pentti Rokkanen) had to develop an entity of tests suitable for the study. The guidelines of the American Academy of Orthopaedic Surgeons on the measurement of joint motion had already been published (American Orthopaedic Surgeons 1966) and were used as a basis for classifications. Although some chosen tests were disease specific, the aim was not on diagnosis. Instead the main purpose of the clinical examination was to enable the creation of an index describing the participant's overall musculoskeletal functional ability, including that of the low back. The same tests were also used in the current study.

The reliability of clinical tests is an integral part of their usefulness. Reliability refers to the agreement between several recordings. It is subdivided into intra-rater and inter-rater reliability (Mitchell 1979). High intra-rater reliability is described when the same examiner can repeat the measurement consistently, and high inter-rater reliability when two or more examiners can repeat the measurement consistently. Differences in the test protocol between examiners is a common source of decreased inter-rater reliability. Here, for example, the amount of strength used in palpation, sensitivity to recognize spasm in muscles, and the performance of passive motion assessments may have differed between examiners. To increase reliability, one physiotherapist did the great majority of the clinical examinations in this study, and training for using the test protocol was arranged before the beginning of the study.

There is no information available, regrettably, on the reliability of the clinical low back findings at baseline. However, in 1973 the intra-examiner reliability of the total musculoskeletal findings score (of 27 items) was assessed in a sample of 54 subjects whose examination was repeated within 2 weeks from the original measurement by the same physiotherapist. Based on these repeated measurements the reliability of the total clinical findings score was high ($r = 0.84$ overall; 0.93 in men, 0.77 in women).

Because in our study the reliability of the single tests was not analysed and because the reliability results for an index of clinical findings similar to ours have not been published, comparison between studies is rendered difficult. However, in the literature there are studies where the reliability of the single tests that were used in our study, were evaluated.

Perret et al. (2001) reported an excellent intra- and inter-observer reliability for the fingertip-to-floor test with an intraclass correlation coefficient of 0.99. The distance from the fingertip to the floor was measured using a tape measure. Also, the study by Magnussen et al. (2004) reported a very high inter-observer reliability for the fingertip-to-floor test with the kappa value of 0.96.

Stochkendahl et al. (2006) evaluated the reproducibility of spinal palpation in a systematic review. The authors found an acceptable inter-observer reproducibility for palpation of pain in osseous structures and in soft tissue. The reported kappa values were 0.53 and 0.42, respectively. According to another systematic review palpation of muscle tension or spasm had low reliability (May et al. 2006).

Rebain et al. (2002) evaluated the intra- and inter-observer reliability of the SLR test in a systematic review and found that in most studies reliability was good. In a study by Strender et al. (1997) it was also observed that the SLR test had a good inter-observer reliability with κ = 0.83 among patients with LBP.

Although clinical measures are often regarded as objective, they include subjective components. Certain non-physical factors may have an influence on the measurements: fear of moving because of pain, motivation, and restriction of movement due to muscular strain (Al-Obaidi et al. 2000, Moreau et al. 2001). These factors may lead to underestimating the capacity of the spine.

6.1.4 Hospitalization due to low back disorders

Hospital admissions were considered as an indicator of a severe low back disorder in the current study. In the case of hospital admission, usually a diagnosis has to be given, based on the subject's symptoms and the results of clinical examinations. Thus, hospital admission due to a low back disorder can also be considered as more objective and reliable than purely symptom-based measures.

We examined hospitalization during almost three decades of follow-up. During such a time span clinical practices and guidelines regarding indications for hospitalization due to low back disorders may have changed considerably. As also the health care system developed and expanded, the probability of hospitalization probably increased among the cohort during the follow-up. However, these changes had their effect on the (surviving) members of the cohort to an equal degree in practice, as the great majority (over 80 %) of hospitalizations were to one hospital only (the Central Hospital of Central Finland). Information on hospitalizations in the primary health care was missing.

Many person-bound factors other than the severity of the disorder may have an influence on hospitalization. Hospitalization is a process initiated by the back pain sufferer seeking care from a health care system for pain symptoms or disabilities. Usually, primary care physicians assess the severity of symptoms and the need for care as well as the need for referring the patient to specialized care within the hospital. In Finland, access to a central hospital is gained through public primary health care, the occupational health service, private sector or through the emergency room.

Hospitalization due to low back disorders is a rare event. In Finland 0.4 % of the working population in 1996 were hospitalized due to back disorders (Leino-Arjas et al. 2002a). In the same population, one half of all back-related hospital admissions had a diagnosis code referring to lumbar intervertebral disc diseases.

In Finland, the principal aims of the health care policy have been equality irrespective of place of residence, and the usage of services according to need. To a great extent, these goals have been met and even surpassed (Keskimäki et al. 1995). However, a comprehensive register-based study showed that unemployment and low income were inversely related to hospitalization due to lumbar intervertebral disc disorders (Leino-Arjas et al. 2002a). In addition, there exists regional variation in lumbar disc operation activity between hospitals in

Finland (Keskimäki et al. 1994). In our study more than 80 % of hospital admissions were to a single hospital (Central Hospital of Central Finland). Therefore, regional variations in admission policies had only a minor influence.

6.2 On the main findings

The prevalence of radiating LBP, but not that of local LBP, increased with age at baseline and with the aging of the cohort (Figure 4). This is in accordance with findings from a representative sample of adult Finns in 2000, in which the prevalence of LBP was highest in the age group of 75 to 84 years, with 43 % of women and 40 % of men reporting pain (Heistaro et al. 2007).

6.2.1 Incidence and persistence of low back pain (I)

Increasing age was associated with new reports of radiation of LBP to the legs during the follow-up period. The trend was observed notably between the second and at the last survey. This finding is very interesting because it is assumed that the incidence rates of LBP peaked between the fourth and the fifth decades of life, and decreased to a minor extent thereafter (Kopeck et al. 2004). Previous knowledge of back pain among persons aged 65 years and older is limited due to the fact that most of the studies focused on working-age people only.

LBP was a common and persistent symptom throughout the follow-up period. Logistic regression analyses showed that those with LBP at baseline had a six-fold risk for similar symptoms at the 5-year follow-up examination and still a four-fold risk in the last survey. Although follow-up periods have been shorter than in our study, previous literature consistently shows that a history of LBP predicts new episodes of LBP (Croft et al. 1998, Müller et al. 1999, Thomas et al. 1999). In a prospective study by Hestbaek et al. (2003), which focused on a general population sample aged 30 to 50 years, those with LBP at baseline were four times more likely to have a new episode of LBP at the one-year follow-up examination and twice as likely to suffer from LBP at the 5-year follow-up examination. However, the response rate was only 59% in the last follow-up (Hestbaek et al. 2003). Also, Smedley et al. (1998) examined the association between the history of LBP and similar symptoms that might recur using three-month intervals for two years among female nurses aged between 19–64 years. Of those with LBP at baseline, 40% reported similar symptoms at the next follow-up examination, and 39% two years later (Smedley et al. 1998).

Radiation of LBP to the legs at baseline predicted subsequent similar symptoms, especially over the first two follow-ups. Those with radiation of LBP to the legs at baseline had an almost nine-fold risk for similar pain at the 5-year follow-up and a seven-fold risk at the 10-year follow-up compared to those without radiation of LBP to the legs. This finding is in line with previous studies with shorter follow-up periods (Riihimäki et al 1989, Tubach et al 2004). In the study by Tubach et al. (2004), of persons radiating LBP at baseline, 53% suffered from similar symptoms after four years. In a prospective study among concrete reinforcement workers and house painters it was shown that those with radiating LBP at baseline had a three-fold risk of similar pain at the five-year follow-up than persons without radiating pain (Riihimäki et al. 1989).

6.2.2 Associations of low back pain with neck pain (II)

We found a clear association between LBP and NP in cross-sectional analyses at every follow-up examination; the strongest association was observed between radiating LBP and radiating NP. In spite of differences in the classification of spinal pain, our findings are in line with previous cross-sectional studies (Côté et al. 2000, Yeung et al. 2002, Vogt et al. 2003, IJzelenberg and Burdorf 2004, Guez et al. 2006, Haukka et al. 2006). In the German population, 37% of men and 56% of women with LBP had concomitant NP (Schneider et al. 2006). In addition, the authors of a recent Finnish study found that among female kitchen employees who had LBP 83% reported concurrent NP (Haukka et al. 2006).

The associations between radiating LBP and radiating NP can be due to the high prevalence of both radiating LBP and NP. In a representative sample of Finns aged 18 years and older, approximately 30% of men and 40% of women reported having suffered from radiating LBP at least once during their lifetime (Heistaro et al. 2007). In the same sample the lifetime prevalence of neck pain was 54% among men and 68% among women (Leino-Arjas et al 2007). The main risk factors identified for radiating LBP and radiating NP are also quite similar, for example, age, heavy workload, smoking, obesity, and mental stress (Heliövaara 1989, Viikari-Juntura et al 2001, Miranda et al. 2002).

Concurrent LBP and NP can also be due to individual differences in susceptibility to pain in general (Mogil, 1999; Hartvigsen et al., 2004). Recently, Gatchel et al. (2007) reviewed studies on the associations between several biological and psychosocial factors and chronic pain. According to the authors psychological factors such as emotion and cognition as well as social factors can interact with brain processes and thus influence pain perception.

In our study, we also found associations between LBP and NP prospectively, with radiating LBP at baseline predicting subsequent radiating NP with an RR of 2.5 at the 5-year follow-up and 2.3 at the 10-year follow-up. Although comparable long-term prospective studies have not been reported, our findings are congruent with previous results in short prospective studies (Croft et al. 2001, Hill et al. 2004, Hoving et al. 2004). Croft et al. (2001) studied risk factors for NP among an adult general population sample in the United Kingdom. Persons who were free of NP at baseline but reported a history of LBP, had a two-fold risk for experiencing NP over a one-year follow-up period. Some other factor than general susceptibility to pain may be involved in such associations. They might be better explained by some vulnerability factor of the spine, perhaps genetically based, in addition to the possibility that shared risk factors could lead to LBP and NP in an individual at different time points.

6.2.3 Clinical findings and pain in the low back (III)

In our study, severe clinical findings at baseline predicted new reports of radiating LBP at the 5- and 10-year follow-ups and new reports of local LBP at the 10-year follow-up. To the best of our knowledge, no other long term prospective studies in a working population on the associations between clusters of clinical findings and new radiating LBP have been published. Previous studies have mainly investigated associations between single tests and LBP without pain classification as local and radiating.

Michel et al. (1997) examined associations of 34 clinical tests with the intensity of and disability caused by back pain. The participants were identified by a survey of the normal population. It was found that thoraco-lumbar rotation, lateral flexion, fingertip-to-floor distance, scoliosis, pain on percussion of the spine, and the SLR test correlated best with the severity of pain. As the source of LBP can be in many of the spinal structures, it has been suggested that clustering the results of several measurements may enhance their diagnostic or prognostic ability (De Hertogh et al. 2007).

Waddell et al. (1992) created an index of clinical impairments in the low back that could discriminate between persons with or without non-specific LBP. The following tests were included: flexion and extension of the lumbar spine, average lateral flexion, average straight leg raising, bilateral active straight leg raising, spinal tenderness, and sit-up (Waddell et al. 1992). This index was a reliable and valid measure of physical impairment for patients with acute LBP as well (Fritz and Piva 2003). According to the previous studies, clinical findings such as restrictions of the spine mobility, positive SLR test and spinal tenderness seem to have value as determinants when evaluating the severity of LBP in clinical practice. We found similar tests to be important in our clinical assessment of the lumbar spine.

In the present study clusters of clinical findings predicted radiating LBP, especially. This finding is in line with some previous cross-sectional studies, where radiating LBP was more strongly related to limited function than local LBP. Thomas et al. (1998) examined associations between spinal mobility and LBP among persons who visited general practices. Compared to women with local LBP women with radiating pain had more restriction in lumbar spine extension, lateral flexion and forward flexion (Thomas et al. 1998). No similar association was found among men. In another study of male patients with chronic radiating LBP and a positive SLR test, poorer self-reported physical function was noted than in men with only local LBP (Ren et al. 1999). Of a sample including persons referred to surgeons due to chronic LBP, 93% had radiating LBP, 60% had limited spinal flexibility, 71% muscle tenderness or spasm, and 43% had a positive SLR test (Long et al. 1996).

In the present study there was no association between limited forward flexion at baseline and future radiating LBP during the follow-up period. A recent review by Hamberg-van Reenen et al. (2007) concluded that the relationship between reduced lumbar flexion and future LBP is unclear. The evidence from prospective studies (with follow-up periods from 1 to 4 years) was conflicting, in that two such studies reported that a larger flexion or flexion-extension range was predictive of LBP (Biering-Sørensen, 1984, Troup et al. 1987), while two others reported contrariwise that a reduced lumbar flexion range was predictive of LBP (Adams et al., 1999, Takala and Viikari-Juntura, 2000). Our results, then, add to the balance with the finding of no association between flexion range at baseline and new reports of LBP at 5, 10 or 28 years from baseline. According to Hamberg-van Reenen et al. (2007), this is what a best evidence synthesis would conclude.

We could not analyze the association between the SLR test with future radiating LBP because of the small number of positive test results. One earlier study has shown that a positive SLR test predicted subsequent care seeking due to LBP in a 4-year follow-up among workers (Battié et al. 1990b). In that study a positive SLR test result was defined in a similar way to our study.

6.2.4 Hospitalization due to low back pain (IV)

Although LBP was a very common symptom among our cohort, hospital admissions due to low back disorders were a rare event with 51 persons (5.7%) hospitalized due to low back disorders during the long follow-up period. Half of those had diagnoses referring to disc diseases. These results are consistent with a previous study comprising the whole occupationally active population in Finland (Leino-Arjas et al. 2002a).

In our study the occurrence of both local and radiating LBP at baseline were predictors for subsequent hospitalization due to low back disorders. However, the risk of the hospital admission was higher for those with radiating LBP than for those with local LBP. The results of the prospective study by Shekelle et al. (1995) showed that high pain intensity and high disability at baseline were predictive of receiving health care during a follow-up period of 3 or 5 years. In another study of persons with radiating LBP around 50% had sought care while the respective figure for those with local pain only was 30% (Carey et al. 1996).

We also observed that clinical findings in the low back at baseline were related to hospital admissions. Although there were no previous studies on the relationship between an index of lumbar spine function and hospitalization, the findings of our study are congruent with previous results concerning care seeking due to LBP. In a cross-sectional study by Long et al. (1996) different kinds of clinical findings in the low back were very common among those who were referred to hospitals due to LBP. Takala and Viikari-Juntura (2000) examined relationships between a group of a single physical performance tests for the lumbar spine area and care seeking. Pain in sideways bending of the lumbar spine, measured by the distance from the floor to the finger tips, predicted medical consultation due to LBP over a two year follow-up period in men (Takala and Viikari-Juntura 2000).

Low back pain is among the most important causes of sickness absence from work. Even though there was only a retrospective self-report of sickness absence due to LBP available in our material, we could see that such a report was predictive of a low back disorder severe enough to lead to hospitalization (and most probably an even longer sickness absence). This indicates a potential for intervention: subjects with short-term work disability due to LBP might be a target group well reachable via the occupational health care system for closer scrutiny of the nature of the ailment and assessing possible aggravating working conditions, and for rehabilitative and therapeutic treatment and lifestyle advice.

6.3 Generalizability of the results based on the METELI–cohort

The METELI study sample comprised of men and women employed at the beginning of the 1970's by one large engineering company in Central Finland. To become members of the cohort, the subjects also had to be willing to respond to questionnaire surveys and take part in a rather comprehensive health examination.

The cohort consisted of both white-collar and blue-collar industrial employees in the choice of occupations and tasks that the Valmet (later Metso) company had to offer, ranging from foundry and heavy engineering to precision engineering and clerical and managerial work. The working conditions and staff were considered as corresponding to those of other similar manufacturing industries at large at the time (METELI, 1975). Although the cohort was designed so as to be thus characteristic of the Finnish industrial employee population, it was, on the other hand, selected to a degree. In the sampling, there was an ambition to secure as large a range of leisure-time physical activity as possible, by arranging the subjects, by strata (age, gender, occupational class), in an ascending order according to a physical activity score obtained in the preliminary questionnaire mentioned above. In the strata, a systematic sampling of subjects was made. The sampling was non-proportional favouring the smaller groups (managers, white-collar women). It is obvious that the sampling was not a random sample of the employees in the company. However, the sampling procedure produced study material that enabled stratified analyses by basic sociodemographic characteristics without leading to bias of substance, and enhanced as well the participation activity later in the follow-ups.

Statistics Finland has evaluated the changes that took place in working conditions from 1977 to 2008 in Finland based on employees' perceptions (Lehto and Sutela 2008). A considerable increase occurred in the use of computer-based work. However, the prevalence of occupational physical hazards such as repetitive movements, working in awkward positions, heavy lifting, and vibration, remained, surprisingly, stationary or even increased. Of these, working in awkward positions and repetitive movements were considered as the most harmful by employees (Lehto and Sutela 2008). Based on these surveys it seems that the occurrence of work-related risk factors of LBP has not decreased in Finnish occupations during the past three decades. As the data were based on self-reports, there remains the possibility that standards by which evaluations are made, have changed. Yet, occupations with physical hazards considered by many as risk factors of LBP still occur. In this light the results of the present study are relevant even for today's working life when associations of physical work load with health are discussed (Kirjonen 2009). The follow-up time was long, and working conditions and tasks certainly changed during it, however LBP was very common at every follow-up.

7 CONCLUSIONS

LBP was a very common symptom among the employees studied, with one half of the participants reporting some low back trouble and one quarter having local pain and another quarter LBP with a radiating component at baseline. This study supports the view that LBP is very often recurrent or persistent and that a history of pain in working-age predicts future symptoms considerably later in older adulthood.

It seems that effect of aging on local LBP is different from that on radiating pain. While the prevalence of local LBP remained at the same level, that of radiating LBP increased with the ageing of the cohort. At the last follow-up, when the average age of the cohort was 62 years, one half of the participants reported radiating LBP. Many persons with local LBP at baseline suffered from radiating pain in the later part of their life. It seems that local pain precedes radiating pain.

The results also point out differences between LBP perceived locally and LBP with a radiating component. Radiating LBP was connected with radiating NP, especially, irrespective of ageing, and predicted new reports of radiating NP. Here our findings extend previous results obtained from cross-sectional studies.

We also found that associations of clinical findings in the low back were more pronounced with radiating than local LBP, and that severe clinical findings predicted new reports of radiating LBP over a long period of time. However, self-reported radiating symptoms in the low back and back-related absenteeism from work were better predictors of severe back disorders requiring hospital care than clinical findings.

8 NEEDS FOR FURTHER RESEARCH

The definition of LBP has been inconsistent across studies. Due to the lack of established standardized definitions of LBP it is difficult to compare their results. There is an obvious need to develop well-founded and feasible measures of LBP that could be more consistently used in epidemiological studies. It seems that the consequences of radiating LBP are often more severe than those of local LBP. Therefore a classification of LBP based solely on the duration of symptoms as acute versus chronic is not adequate enough; in the future, LBP should preferably be categorized as local and radiating as a minimum additional requirement. Recently, there have been some attempts of this kind (Dionne et al. 2008, Bogduk 2009). Further, future studies should try to identify potential sub-groups within the category of radiating pain that may differ in the risk of severe consequences. Studies are also needed for the identification of possible differences in the aetiology between local and radiating LBP. A validated and reliable test method to assess the clinical status of the low back for epidemiological studies is needed.

The present study also showed a clear association between increasing age and radiating LBP, till the age group above 75 years. This finding is important because it is often assumed that the occurrence of LBP increases up to the age of 45-64 years and decreases thereafter. In future studies, the course of LBP in senior persons should be addressed.

The role of individual and environmental factors that increase vulnerability to concurrent LBP and NP should be examined. A better understanding of the factors that affect the spinal structures or perception of pain arising from the spine is needed to enable the development of preventative interventions to maintain and improve the health of the spine.

YHTEENVETO

Metalliteollisuuden työntekijöiden alaselän sairaudet ikääntyessä: METELI-tutkimuksen 5–, 10– ja 28–vuotisseurantatutkimus

Tämä tutkimuskokonaisuus muodostuu neljästä osajulkaisusta ja yhteenvedosta. Tutkimuksen tarkoituksena oli selvittää paikallisen ja säteilevän selkäkivun esiintyvyyttä, pysyvyyttä, ilmaantuvuutta sekä yhteyttä niskaoireisiin ja sairaalahoitoihin. Lisäksi tutkittiin fysioterapeutin tekemien alaselän alueen kliinisten löydösten yhteyttä oireisiin.

Tutkimuksen perusjoukon (n=4750) muodostivat ne Jyväskylän alueella toimivien kolmen Valmet-tehtaan työntekijät, jotka olivat olleet työsuhteessa vähintään 15 kuukautta tutkimuksen alkaessa. Tutkimukseen osallistui 902 työikäistä henkilöä (609 miestä ja 293 naista). Tutkimusaineisto kerättiin kyselyin ja kliinisin mittauksin. Tutkimus aloitettiin vuonna 1973 ja seurannat tehtiin vuosina 1978, 1983 ja 2000. Koko seurantajakson aikana kuoli 232 henkilöä. Osallistumisaktiivisuus seurantoihin pysyi hyvänä: elossa olleista henkilöistä 84 % osallistui seurantamittauksiin 5 vuoden seurannassa, 76 % 10 vuoden seurannassa ja 81 % 28 vuoden seurannassa. Tiedot kuolleista kohortin jäsenistä perustuivat Tilastokeskuksesta saatuihin tietoihin. Tiedot sairaalahoidoista saatiin hoitoilmoitusrekisteristä vuosilta 1973-2000.

Tutkimukseen osallistuneilla henkilöillä selkäkipu oli hyvin yleinen ja pysyvä tai uusiutuva oire koko tutkimusjakson ajan. Ikääntyminen vaikutti eri tavoin paikallisen ja säteilevän selkäkivun esiintymiseen: paikallisen oireen esiintyvyys pysyi samalla tasolla tutkimusajankohdasta toiseen, kun taas säteilevän selkäkivun esiintyvyys lisääntyi. Lähtötasolla 54 % oli kokenut selkäkipua viimeisen 12 kuukauden aikana, heistä 29 % paikallista kipua ja 25 % säteilykipua. Lähtötasolla selkäkivusta kärsineistä henkilöistä 75 %:lla oli sama vaiva viiden vuoden seurannassa, 73 %:lla 10 vuoden ja 88 %:lla 28 vuoden seurannassa. Paikallisen selkäkivun vastaavat uusiutumisprosentit olivat 45 %, 38 % ja 33 %, säteilevän selkäkivun 66 %, 65 % ja 69 %.

Uusista selkäoireista raportoivien osuus kasvoi seurannan aikana. Lähtötasolla oireettomista henkilöistä 33 % ilmoitti paikallista selkäkipua viiden vuoden seurannassa, 37 % 10 vuoden ja 65 % 28 vuoden seurannassa. Vastaavasti niiden joukossa, joilla ei ollut säteilykipuoiretta lähtötasolla, 17 % oli kokenut säteilevää selkäkipua viiden vuoden seurannassa, 22 % 10 vuoden ja 46 % 28 vuoden seurannassa.

Selkäkipu oli yhteydessä niskakipuun jokaisena tutkimusajankohtana. Selkäkipu lisäsi paikallisen niskakivun riskiä noin kaksinkertaiseksi. Säteilevä selkäkipu lisäsi yläraajoihin säteilevän niskakivun riskiä noin kolminkertaiseksi. Säteilevän selkäkivun ja säteilevän niskakivun yhteys säilyi samana ikääntymisestä riippumatta. Selkäkipu myös ennusti säteilevää niskakipua viiden ja 10 vuoden seurannassa niillä henkilöillä, joilla ei ollut säteilevää niskaoiretta lähtötasolla.

Selän kliininen tutkimus koostui kahdeksasta mittauksesta: lannerangan eteentaivutus, lannerangan alueen lihasten palpaatioarkuus ja lihasjännitys, palpaatioarkuus lannerangan nikamaväleissä LIII-SI sekä suoran jalan nostotesti. Lähtötasolla positiivinen kliininen löydös vähintään yhdessä mitatussa testissä oli yhteydessä usein esiintyvään ja säteilevään selkäkipuun sekä itseilmoitettuun sairauspoissaoloon selkäkivun takia. Tämän lisäksi viidestä mittauksesta (palpaatioarkuus nikamaväleissä LIII–SI ja suoran jalan nostotesti) muodostettiin klusterianalyysin avulla löydösmuuttuja, jolla luokiteltiin henkilöt löydösten ja niiden vakavuuden perusteella kolmeen ryhmään: ei löydöksiä, vähäisiä löydöksiä, runsaasti löydöksiä. Löydösmuuttuja ennusti uusia ilmoitettuja selkäkipuja. Henkilöillä, joilla oli huomattavia löydöksiä lähtötasolla, mutta ei säteilevää selkäkipua, oli lähes nelinkertainen säteilevän selkäoireen riski viiden vuoden seurannassa ja kaksinkertainen riski kymmenen ja 28 vuoden seurannassa verrattuna henkilöihin, joilla ei ollut löydöksiä lähtötasolla henkilöillä. Niiden joukossa, joilla ei lähtötasolla ollut paikallista selkäkipua, kuuluminen runsaiden löydösten ryhmään ennusti paikallista selkäkipua 10 vuoden seurannassa.

Huolimatta siitä, että selkäkipu oli hyvin yleinen oire tässä aineistossa, vain 51 henkilöä oli joutunut sairaalahoitoon selkäkivun takia vuosina 1973-2000. Useat eri tekijät lähtötasolta ennustivat sairaalahoitoja. Parhaiten sairaalahoitoon joutumista selittivät säteilevä selkäkipu, usein esiintyvä kipu sekä krooninen selkäkipu.

Yhteenvetona voidaan todeta, että selkäkipu on hyvin yleinen oire niin työikäisillä kuin myös sitä vanhemmilla henkilöillä. Selkäoire esiintyy usein niskaoireen kanssa samanaikaisesti. Pitkällä aikavälillä säteilevän selkäkivun seuraamukset ovat vakavampia kuin paikallinen selkäkivun. Säteilykipu oli oireena pysyvämpi tai toistuvampi, se ennusti säteilevän niskaoireen ilmaantumista ja oli voimakkaammin yhteydessä alaselän alueen kliinisiin löydöksiin ja sairaalahoitoihin. Tutkimustulokset tukevat käsitystä että selkäkivun jako paikalliseen ja säteilevään oireeseen on väestötutkimuksissa perusteltua.

Avainsanat: selkäkipu, niskakipu, työntekijät, kliiniset löydökset, sairaalahoidot, kohorttitutkimus

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Appendix 1: The questionnaire items on musculoskeletal pain.

Have you felt an ache, stiffness, sensitivity to movement, numbness or pain in the joints or muscles of the areas listed below, and how often during the past 12 months?

		Never	Sometimes	Rather often	Often or continuously
Shoulders or upper arm	On the right	1	2	3	4
	On the left	1	2	3	4
Elbow or forearm	On the right	1	2	3	4
	On the left	1	2	3	4
Wrist, hand or fingers	On the right	1	2	3	4
	On the left	1	2	3	4
Hip	On the right	1	2	3	4
	On the left	1	2	3	4
Knee	On the right	1	2	3	4
	On the left	1	2	3	4
Calf	On the right	1	2	3	4
	On the left	1	2	3	4
Angle or foot	On the right	1	2	3	4
	On the left	1	2	3	4
Ball of the foot or toes	On the right	1	2	3	4
	On the left	1	2	3	4
Cervical spine or back of the head		1	2	3	4
Does pain in the neck radiate up to the upper extremity?	On the right	1	2	3	4
	On the left	1	2	3	4
Thoracic spine, between the scapulas		1	2	3	4
Lumbar spine		1	2	3	4
Does pain in the low back radiate to the thighs or toes?	On the right	1	2	3	4
	On the left	1	2	3	4

Appendix 2: The questionnaire items on distress symptoms.

Have you had some of the following symptoms and how often during the past year?

	Seldom or ever	Sometimes	Rather often	Often or continuously
Heartburn or acid trouble	1	2	3	4
Loss of appetite	1	2	3	4
Nausea or vomiting	1	2	3	4
Abdominal pains	1	2	3	4
Diarrhea	1	2	3	4
Sleeplessness	1	2	3	4
Nightmares	1	2	3	4
Headache	1	2	3	4
Lack of sexual interest	1	2	3	4
Dizziness	1	2	3	4
Tachycardia or palpitation	1	2	3	4
Tremor of the hands	1	2	3	4
Excessive perspiration without physical effort	1	2	3	4
Dyspnoea	1	2	3	4
Lack of energy	1	2	3	4
Fatigue or weakness	1	2	3	4
Anxiety or nervousness	1	2	3	4
Irritability or fits of anger	1	2	3	4