MATTI MÄKELÄ

Common Musculoskeletal Syndromes

Prevalence, Risk Indicators and Disability in Finland

Helsinki 1993
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To be publicly discussed, by permission of the Faculty of Medicine of the University of Helsinki, in the small auditorium of the Meilahti Theoretical Departments, Haartmaninkatu 3, on August 21st, 1993, at 12 o'clock noon

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COMMON MUSCULOSKELETAL SYNDROMES
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Abstract


The prevalence and risk indicators of low back pain, neck pain, hip osteoarthritis and fibromyalgia, and the disability associated with these syndromes, were studied in a survey representative of the Finnish population aged 30 years or more. Physical stress at work and a history of injury to the specific body region were risk indicators of all the syndromes except fibromyalgia. Overweight was a risk indicator of hip osteoarthritis, mental stress at work of back and neck pain and heavy smoking of low back pain. Low back pain, neck pain and osteoarthritis were risk indicators of each other, even accounting for other common determinants. Inflammatory arthritis, osteoarthritis and low back pain were determinants of disability, and together all musculoskeletal disorders accounted for about 20% of the population disability burden.

Key words: backache, neck pain, osteoarthritis, risk factor, disability

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Avainsanat: selkäkipu, niskakipu, nivelrikko, vaaratekijä, toiminnanvajavuus
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This study is based on the Mini–Finland Health Survey, a comprehensive health examination survey done by the Social Insurance Institution (SII). The principal aim of the survey was to provide information for use in the prevention of illness and disability and in the evaluation, planning and improvement of health services. The present study, a complement to the main reports of the survey, was undertaken to provide a comprehensive picture of the distribution, risk indicators and disability associated with common musculoskeletal syndromes, especially low back pain, chronic neck pain, osteoarthritis and fibromyalgia.

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Helsinki, May 1993

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I. Introduction

Musculoskeletal disorders are causes to more painful days and absence from work than any other main group of chronic illness. Almost everyone has some trouble from the musculoskeletal system at one time or another. On the basis of the Mini-Finland Health Survey done by the Social Insurance Institution it can be estimated that more than 1.7 million Finns (out of five million) have suffered from some kind of musculoskeletal pain during any given month, more than a million fulfil the criteria for one or several musculoskeletal disorders, and in more than half of these it is the cause of functional limitation (Aromaa et al. 1989a; Sievers et al. 1990).

Knowledge about the conditions leading to a chronic musculoskeletal syndrome is needed. Not only would such knowledge provide guidelines for preventive interventions, it could also help each patient reconstruct the story of his or her plight. Epidemiological studies are one source of this kind of knowledge. They provide a real-life testing ground for hypotheses generated in clinical practice, laboratories or from theoretical models.

It would be nice and neat if musculoskeletal disorders could be identified and classified by causative agents like the infectious diseases are, or by distinct pathological anatomy like the neoplastic diseases. This would lead to precise diagnostic categories for epidemiologists to identify with known sensitivity and specificity, and thence to research into definite preventive action. However, most cases of chronic pain in the musculoskeletal system are not so definable. The vast majority of low back pain and pain in the neck and shoulder region are only that. Even osteoarthritis, despite having certain characteristic pathological features, shares the problem. The pain and impairment lack adequate explanation, as the association of pain and pathological change is far from complete.

One approach to the public health problem of musculoskeletal disorders is to accept the vagueness of diagnosis and operate on categories of symptom
complexes. The basis of classification in this approach is pain and impairment, as reported by people themselves or observed by an examiner. This differs from cardiovascular diseases, where symptom complexes are used as proxy measures of actual pathological changes; in many cases of musculoskeletal pain, the syndrome is all we know of the phenomenon.

Studying the epidemiology of a syndrome is technically not different from studying the epidemiology of a disease. One still needs a precise definition of the entity in question – one must separate a case from a non-case. One still tries to identify subpopulations with an increased or decreased occurrence of the syndrome, and unravel the features that characterise these populations. The goal is to understand the causes of the syndrome.

Certain differences are inevitable. First, as there is no external, undisputable criterion to separate a case from a non-case, the prevalence of chronic musculoskeletal pain syndromes is strictly speaking arbitrary. This problem may be reduced by using carefully defined operational criteria. Second, the number of possible causal pathways, and the levels on which they act, is even less defined than in the case of a clear-cut disease entity. Interpreting the identified risk indicators has therefore a special challenge.

Many risk indicators of common musculoskeletal syndromes have been identified. Heavy labor, trauma, poor education, unpleasant working conditions, and mental distress are variables commonly used in epidemiological studies in this field. Actually, it is striking how similar these risk factors are, be the object of the study osteoarthritis of the knee, hip or hands, low back pain, neck pain or the associated disability. It is tempting to take a look at all of these syndromes simultaneously and see exactly how similar they are in their risk indicator profiles.

Disability and handicap are consequences of disease, defect or other disorder, and musculoskeletal disorders can certainly be causes of disability. There is, however, no rule saying that a disability can only have one cause. Multiple causes, including several simultaneous disorders, are more the rule than the exception. This leads to a special problem when evaluating the
effect musculoskeletal disorders have on the public health problem of disablement. A vague musculoskeletal syndrome may be aggravating the disabling effect of a disease which has a more respectable diagnostic criterion. This would lead to a misleading estimate of the relative or absolute impact of the syndrome. An appropriate approach would therefore require simultaneous assessment of all comorbid conditions, in addition to possible other determinants of disability.

In this study, the prevalence, risk indicators and disability associated with several common musculoskeletal syndromes are investigated in a health survey. The distinguishing features of this survey are that it is relatively large; it is representative of the general population; the definitions of the syndromes are based on both a clinical examination and the presence of subjective symptoms; a large number of chronic disorders, musculoskeletal as well as others, were identified simultaneously; and assessment of disability was independent of the diagnostic procedure.
II. Literature review

A. Conceptual models used in epidemiological studies of common musculoskeletal disorders

Any epidemiological study of chronic musculoskeletal pain takes an implicit stand on the imagined etiological and pathogenic model behind the pain. This model influences which variables are considered possible risk factors and the way the investigator treats them in his analysis. The same model also affects the classification of the individual health states into distinct disorders (Wood 1986). Some of these disorder categories can be called diseases, when accompanied by a known pathophysiology. Other disorders qualify for the status of syndrome, when they are characterised by a collection of related symptoms or findings.

1. Current classification of chronic musculoskeletal disorders

The ninth revision of the International Classification of Diseases (WHO 1977) reflected (though not completely) a major revision in the classification principles of musculoskeletal disorders (Wood 1986). The obviously inflammatory, "classic" diseases of the connective tissue and joints, including infectious, crystalline and reactive arthropathies as well as the rheumatoid arthritis family occupy one branch of the classification. This group of diseases also includes items in the broad classes of dorsopathies (ankylosing spondylitis) and soft tissue disorders (polymyalgia rheumatica). The second large group is that of degenerative joint disease, osteoarthritis or osteoarthritis, with inflammation in a minor role and a pathogenetic basis in the loss of joint cartilage (Wood and Badley 1986; Hamerman 1989). Third, dorsopathies, or disorders of the back, form a group of their own, most of which have an obscure etiology and pathogenesis. The bulk of the problem is represented by low back pain and chronic neck pain. The fourth large group is that of soft
tissue disorders, of which disorders with pain and functional limitations in tendons, tendon sheaths, ligaments, fasciae, bursae and ligamentous entheses (enthesopathies) are the most common (Uthoff and Sarkar 1991).

Of special interest is the way broad categories of musculoskeletal disorders are subdivided (Wood 1986). In clinical practice, a hypothetical etiology is often preferred to admission of ignorance (Jensen 1983), but more often than not, such assumptions are unwarranted when classifying chronic musculoskeletal pain (Wood 1986; Spitzer et al. 1987; Felson 1988).

Certain subgroups of low back pain can be separated with good conscience (Spitzer et al. 1987). There are cases with obvious traumatic etiology, and naturally some due to tumours or infection. These groups are so small that in population-based epidemiologic studies they can be ignored (Spitzer et al. 1987). Therefore, the only epidemiologically practical subdivisions that can be supported by unquestionable facts are those based on duration of symptoms (acute, single-episode low back pain vs. chronic or recurrent pain) and radiation of symptoms along the leg (sciatica vs. other low back pain) (Spitzer et al. 1987; Heliövaara 1989). At this time, no consensus exists on the use of behavioral or mental features or neural mechanisms of chronic pain as classification principles (Coste et al. 1992; LaRocca 1992).

In osteoarthritis, an old clinical subdivision is into secondary and primary osteoarthritis (Altman et al. 1987; Altman 1991). This division is often difficult to establish, as the original cause of the disorder is usually unknown and probably multifactorial (Felson 1988). Such a division is not useful in an epidemiologic context. There is some indication that division into generalised and localised forms of the disorder is useful, and the group developing Heberden's nodes ("nodal") should possibly be distinguished (Altman et al. 1987; Spector and Campion 1989; Altman 1991). An important suggestion is that there is a difference in unilateral and bilateral afflictions (Davis et al. 1989).

In chronic neck pain, no convincing way of separating different epidemiological entities has emerged, and a general concept of chronic pain in the
neck–shoulder region has been widely used (Anderson 1984). Differentiation of impairments of the glenohumeral joint from a more diffuse regional pain syndrome is probably useful, though not entirely simple (Viikari–Juntura 1983).

In the following, the role of some conceptual models of pathogenesis used to understand chronic musculoskeletal pain shall be reviewed, concentrating on how these models have been used in epidemiological studies in connection with degenerative joint disease, dorsopathies, and soft tissue disorders.

2. The inflammation model

There are disorders of chronic musculoskeletal pain with a definite inflammatory component in their pathogenesis. Rheumatic arthritis, spondylarthitis, and calcific bursitis are obvious examples (Wood 1986). Sciatica was considered an inflammatory disorder in the years before the demonstration of nerve root impingement (Mixter and Barr 1934).

Lately, low back pain has again been included in the possible inflammatory disorders of the musculoskeletal system (Brown 1989; Jayson 1989). The mechanism has not yet found definitive support (Jayson 1992).

Several conditions of soft tissue pain, e.g. tendinitis, bursitis and enthesopathies such as epicondylitis, bear the hallmarks of inflammation (Yates 1978). Anti-inflammatory drugs, both steroids and non-steroidal agents, are successfully used in their treatment (Dixon 1979; Dacre et al. 1989). Inflammation is probably a cardinal feature here, even though not necessarily primary; it is a necessary element in the repair process after injury (Uthoff and Sarkar 1991). Nevertheless, the history of fibromyalgia is a cautionary tale: inflammatory changes were seen by some researchers in "fibrositis" (Awad 1973), but reference to inflammation has later been removed even from the name of the condition (Wolfe et al. 1990; Consensus conference 1992).
In osteoarthritis, inflammation is not prominent, although it has been suggested that it may play a part in the pathogenesis of the pain (Zimmermann 1989; Dieppe 1990).

It seems likely that inflammation plays a part in many chronic musculo-skeletal pain disorders. However, this model has not been especially beneficial in epidemiological studies, as it has not yet produced useful risk indicators.

3. Models of muscular tension and reversible biomechanical stress

Unremitting muscular tension is sometimes thought to produce chronic pain without actual damage to tendons, ligaments, synovia or other structures of the joints (LaRocca 1992). Such tension could be due to ergonomic flaws in work place design, habitual postural imbalances or a response to minor damage. This model has been suggested especially in problems in the neck and shoulder region (Herberts and Kadefors 1976; Bjelle et al. 1981; Bjelle et al. 1987; Wallace and Buckle 1987; Linton and Kamwendo 1989), but also in low back pain (Burdorf et al. 1991; Punnett et al. 1991; LaRocca 1992; Rodriguez et al. 1992). There could also be individual variations in the susceptibility because of differences in muscle fibre type composition (Kalimo et al. 1989).

Although muscular tension has not been directly implicated in the pathogenesis of osteoarthritis, it could have a role in the symptoms or consequences (Ekdahl et al. 1989; Kovar et al. 1992).

A muscular imbalance model is implicit in studies associating back pain with a low physical stress level at work, and with a low level of leisure–time physical exertion (Riihimäki et al. 1985; Riihimäki and Mäkinen 1986; Biering–Sørensen 1984; Biering–Sørensen et al. 1989; Burton and Tillotson 1991). Muscular imbalance has also received direct investigation, although there seem to be problems in defining a widely acceptable model (Ahern et al. 1988; Hazard et al. 1991).
4. Models of physical damage to musculoskeletal structures – deformity, trauma and degeneration

The model of major anatomical deformation as a basis for chronic musculoskeletal pain is widely used when studying osteoarthritis (Kellgren 1961; Troyer 1982; Felson 1988; Ragnarsson and Mjöberg 1992), less often in the context of back pain (Saraste 1987; Soukka et al. 1991; Virta 1991). Such deformation may occur after congenital or acquired malformations, trauma or disease.

A major injury has more consequences than just anatomical deformation. It leads to inflammation and reconstruction, which may in themselves play a part in chronic musculoskeletal syndromes (Moskowitz 1984; Hamerman 1989; LaRocca 1992; Vanharanta and Kääpä 1992). Therefore, history of trauma as a risk indicator in the epidemiology of chronic musculoskeletal syndromes is independent of actual deformity.

From experimental models (Troyer 1982) and follow-up studies (Ragnarsson and Mjöberg 1992) it is obvious that traumata can produce osteoarthritis, so this model is a necessary part of the epidemiology of osteoarthritis.

That a rupture and herniation of a lumbar intervertebral disc is a cause of acute sciatic pain is well established (Mixter and Barr 1934; Spitzer et al. 1987), and such an event may take place as a consequence of a sudden forceful accident. An analogy of this model has been used to study chronic low back pain: a provocation of pain of the same quality as that of the chronic complaint by injection of saline or radiographic contrast into the disc is an elegant demonstration that the origin of some such pain is in damaged structures (Vanharanta et al. 1987a; Vanharanta et al. 1988).

Less clear than the effect of major trauma, but potentially extremely powerful, is the model of recurrent cumulative microtraumata (Waris 1979; Kumar 1990; Videman et al. 1990; Radin et al. 1991; Vanharanta and Kääpä 1992). This model employs the concept of microtrauma as an event which in itself
does not raise clinical attention but may trigger reconstructive processes in the tissues. The model further entails that either the reconstruction is less than perfect, or that a new event, before the reconstruction is complete, leads to such an irreversible imperfection. The cumulative effect of these irreversible imperfections is what is commonly called a degenerative process.

Cumulative stress has been extensively investigated in osteoarthritis and has a central role in its biological basis (Troyer 1982; Moskowitz 1984; Hamerman 1989; Radin et al. 1991; Vanharanta and Kääpä 1992; Swann and Seedhom 1993). In the field of epidemiology, the model of cumulative microtraumata is reflected in studies investigating the association of osteoarthritis with occupational overuse (Davis et al. 1989; Felson 1990a; Croft et al. 1992), running (Panush et al. 1986; Marti et al. 1989) and overweight (Davis et al. 1989; Felson 1990a), and that of back pain and heavy work load (Heliövaara 1989; Nachemson 1992) and whole body vibration (Pope and Hansson 1992).

Several writers have pointed out the difficulty in differentiating between "normal" aging and age–related morbidity (Wood 1986; Wallace 1992). In the context of chronic musculoskeletal pain syndromes, age–related changes in the radiological and anatomic appearance of the spine and peripheral joints are well established (Kellgren and Lawrence 1958) but notoriously ill related to the pain (Bigos et al. 1992a). Even the earlier stages of degeneration supposedly detected by magnetic resonance imaging are not consistently associated with pain (Paajanen et al. 1989). It seems that at the biological level, there are differences in the changes in cartilage observed in normal aging and in osteoarthritis (Hamerman 1989), but these are not separable in epidemiological settings.

One specific problem with the degeneration model is the common finding that back pain is less common among the very old than among the middle–aged (Kelsey 1982; Heliövaara 1989). This has been suggested to be related to the loss of turgor and elasticity in the discs and the restabilisation of painful intervertebral joints with age (Heliövaara 1989).
5. Models involving variations in metabolism, including genetic defects

The biology of osteoarthritis, disc degeneration and chronic musculoskeletal pain certainly involve metabolic changes in these living tissues (Moskowitz 1984; Hamerman 1989; Jayson 1989; LaRocca 1992; Vanharanta and Kääpä 1992). The discovery of a gene defect causing early osteoarthritis because of a faulty collagen structure (Palotie et al. 1989) proves that clinical osteoarthritis can be the result of metabolic defects. It remains to be seen if such variations are significant determinants of the variation in morbidity at the population level.

The risk of a ruptured intervertebral disc seems to have a tendency to familial clustering, suggesting a genetically determined vulnerability in some persons. First-degree relatives of patients operated for a herniated disc at a very early age have themselves had the condition up to five times as often as appropriate referents (Postacchini et al. 1988; Varlotta et al. 1991; Matsui et al. 1992). The epidemiological significance of this finding is not clear – juvenile disc herniation is rare (Matsui et al. 1992).

Diabetes, overweight and hormonal changes as risk factors for early generalised osteoarthritis (Spector and Campion 1989; Hannan et al. 1990; Schouten et al. 1992) can be interpreted as evidence of a general metabolic component in the etiology of this disorder. Diabetes has also been implicated in disc degeneration (Silberberg et al. 1986). Vascular changes have been suggested to play a part in intervertebral disc degeneration and back pain (Jayson 1992), and smoking has been shown to influence the integrity of the disc (Battie et al. 1991). A recent development is the suggestion that general processes in the fibrinolytic mechanisms play a part in recovery from episodic back pain (Jayson 1992).

At this time, metabolic variations as epidemiological risk indicators of osteoarthritis and back pain are difficult to interpret and expensive to measure. Thus, few epidemiological studies have addressed these questions.
6. Models involving pain modulation by the central nervous system

Chronic pain involves several central mechanisms in addition to, or instead of, possible tissue damage (Zarkowska and Philips 1986; LaRocca 1992; Pertovaara 1992). This is particularly relevant in the domain of musculoskeletal disorders. A number of neural mechanisms by which nociception may be transformed into chronic pain experience have been suggested (Perry et al. 1989; Peters et al. 1989; Zimmermann 1989; LaRocca 1992). To the extent that these mechanisms differ from one individual to another, they are apt to confound the association between a risk indicator and a chronic musculoskeletal syndrome. Indicators of such central pain modulation mechanisms for use in epidemiological studies do not yet exist.

7. Models involving psychological and cultural concepts

All chronic pain involves psychological dimensions, and musculoskeletal syndromes are no exception (Estlander 1992). These dimensions have attracted many investigative approaches.

The concept of inappropriate illness behaviour (Waddell et al. 1980; Waddell et al. 1984) has produced clinically relevant studies differentiating back pain patients with good or poor prognosis (Waddell 1987a; Waddell 1987b; Murphy et al. 1988; Reesor and Craig 1988; Main et al. 1992) without making assumptions about a psychological origin for such behaviour. Other investigators have preferred to see a diagnosing or measurable mental problem as the distinguishing feature (Coste et al. 1991; Coste et al. 1992; Talo 1992).

Mental distress is a common feature among patients with chronic musculoskeletal disorders (Takala et al. 1982; Hawley and Wolfe 1988; Hyypä and Kronholm 1989; Leino 1989; Feyer et al. 1992). Such distress has been interpreted both as a – more or less adequate – response to the strain of the chronic disorder (Naliboff et al. 1988; Atkinson et al. 1991; Polatin et al. 1993) and an indicator of an increased risk of developing one

Chronic back and neck pain have been seen as responses to stressful life events or unpleasant conditions, especially at work (Magora 1973; Svensson and Andersson 1989; Bigos et al. 1991; Bigos et al. 1992b; Frymoyer 1992). Less has been said about work becoming unpleasant once a musculoskeletal complaint has developed.

The variation in the prevalence of musculoskeletal disorders also has definite determinants in the general structure of society (Allan and Waddell 1989). In addition to compensation reinforcing or discouraging a label of musculoskeletal disorder (Greenough and Fraser 1989), the labour market itself may influence the visibility of the problem (Troup 1984; Clemmer and Mohr 1991).

A special cultural determinant of the "prevalence" of musculoskeletal syndromes is the narrative construction of the syndrome itself (Williams and Wood 1986; Hunter 1991). A striking example is that of "repetition strain injury" in Australia, a condition afflicting primarily the arms, neck and shoulders. It developed into an epidemic, which was curbed by the drastic intervention of renaming the phenomenon "Regional Pain Syndrome", which does not presume knowledge of etiology. As physicians could no longer provide their patients with a culprit to the (often rather diffuse and vague) symptoms, and compensation could not be sought, the problem was again submerged beneath the level of clinical awareness (Hall and Morrow 1988).

Cultural models of chronic musculoskeletal pain syndromes remind us of the fact that the epidemic of musculoskeletal disability (one manifestation of pain) has occurred in industrialised countries without a concomitant increase in any of the central risk factors in the other models of morbidity (Allan and Waddell 1989). Also, the prevalence of chronic neck or back pain is extremely low in some populations, such as the Pima Indians, while the prevalence of other chronic musculoskeletal disorders is high (in this case, rheumatoid arthritis and osteoarthritis) (Jacobsson 1993, personal communication).
8. Conclusions about the conceptual models of musculoskeletal syndromes

Chronic musculoskeletal syndromes, such as low back pain or osteoarthritis, are phenomena of considerable complexity. Not only are they heterogeneous in the population (different cases resulting from different causes), each case also has a complex history of its own. During the development of this history, several of the mechanisms reviewed above can all have an influence on the syndrome.

It seems that at the present time, no definitive model of chronic musculoskeletal pain can be constructed. In every syndrome category there are cases with well-defined specific causes, but a large number of cases are of unknown etiology. It is not possible in epidemiological studies — often not even in the clinic — to separate these (Spitzer et al. 1987; Nachemson 1992).

An epidemiological study must decide on one of two approaches. One could restrict the problem to the domain of one or another model, and restrict the study population to include only a homogeneous subgroup of patients (Miettinen and Caro 1989). In this case, one cannot compare the relative merits of the different pathogenetic models. Another approach is to attempt a comprehensive model, which can produce comparable estimates for the different risk indicators, but says rather little about the actual mechanisms producing the disorders. Another difficulty of the comprehensive approach is that all models of pathogenesis do not readily generate risk indicators amenable to epidemiological measurement.
B. Prevalence and risk indicators of common musculoskeletal syndromes

First, the literature on the prevalence of common musculoskeletal syndromes and their distribution by age and sex shall be reviewed, altogether and separately. Next, the most commonly used risk indicators of the syndromes are reviewed, to provide a background for the analyses used in this study.

1. Prevalence of common musculoskeletal syndromes

Any occurrence estimate of chronic musculoskeletal pain syndromes is to some extent arbitrary and comparisons to any other estimate must be tempered by extreme caution. For instance, it is impossible to draw conclusions, other than that the diagnostic thresholds or criteria differ, from a comparison of two vastly deviant prevalence figures for fibromyalgia, one at 1.1% (Jacobsson et al. 1989), the other at 10.5% (Forseth 1992).

In questionnaire or interview surveys investigating the prevalence of musculoskeletal complaints in general, prevalence figures of 10 to 15% have been typical (Woolsey 1952; Kellgren et al. 1953; Bjelle et al. 1980; Klaukka et al. 1982; Lee et al. 1985), but much higher figures, up to 50% in the adult noninstitutionalised populations, have also been reported (Hult 1954a; Cunningham and Kelsey 1984; Rasmussen et al. 1988). These differences are probably due to differences in wording the questions, and do not warrant a conclusion of truly different prevalences. Complaints are somewhat more common among women than men, except for low back pain, and increase with age at least up to the 70–75 age group (Klaukka et al. 1982; Cunningham and Kelsey 1984; Lee et al. 1985). Different complaints have different occurrence patterns.

Chronic low back pain has been the subject of several surveys (Kellgren et al. 1953; Gyntelberg 1974; Biering-Sørensen 1983; Lavsky-Shulan et al. 1985; Bergenudd and Nilsson 1988; Svensson et al. 1988; Deyo and Bass 1989; Papageorgiou and Rigby 1991; Walsh et al. 1992a; Rekola 1993). In
most of these, the lifetime cumulative incidence of a disabling back pain problem is about 60%, and the period prevalence during the previous year is about 30%. The age distribution reveals an increase in low back pain up to the 50–60-year-old age group and a declining prevalence among the elderly. No good estimate of the prevalence of low back pain in developing countries is available. Although the problem is sometimes seen to affect only industrialised countries (Allan and Waddell 1989), some data suggest that it is common even in Africa (Mulimba 1990).

Chronic pain in the neck–shoulder region is slightly less common than in the low back, with a similar age distribution and a slight preponderance among women (Kellgren et al. 1953; Hult 1954a; Anderson and Duthie 1963; Westerling and Jonsson 1980; Hedberg 1988; Rekola 1993).

The prevalence of osteoarthritis of the knee joint among the total adult population has been put at 4.6% (Hochberg et al. 1989) when using radiologic criteria, and at approximately 10% when using clinical criteria (Allander 1974). Which of these is more correct depends on one's point of view; both are meaningful. The prevalence of hip joint osteoarthritis is lower, maybe approximately 3% (Allander 1974); but it is far less studied than that of the knee joint. Both knee and hip joint osteoarthritis steadily increase in prevalence with advancing age, but the common notion of a high excess of the disorders among women is only observed in some populations (Allander 1974; Davis et al. 1988; Felson 1988). It has been suggested, although not conclusively established, that osteoarthritis is less frequent in a number of developing countries (Valkenburg 1983).

Shoulder joint impairment has been studied as a separate entity in a few surveys (Allander 1974; Cunningham and Kelsey 1984; Jacobsson et al. 1989; Chard et al. 1991). It seems that it is more common among the elderly, the prevalence rising to about 15–20%, while among the middle-aged population it is less than half this figure.

It seems that chronic musculoskeletal pain in the various body regions tends to occur in the same people (Kellgren and Lawrence 1958; Cunningham and
Kelsey 1984; Rekola 1993). They also appear to occur together with other kinds of medical problems (Gyntelberg 1974; Wells et al. 1988; Guralnik et al. 1989; Stewart et al. 1989; Polatin et al. 1993).

2. Risk factors of common musculoskeletal pain syndromes

**Deformity.** A deformation of a joint will induce imbalances in the biomechanical forces on the structures in and around the joint. It would seem inevitable that they would also induce chronic pain syndromes, and indeed, the incidence of osteoarthritis of the hip joint is high in people who have had Legg–Perthés disease or epiphysesolysis of the femoral head (McMurray 1939). It was previously believed that these cases constituted a major portion of osteoarthritis of the hip (Kelihgen 1961; Felson 1988). If this is true, the scope for prevention in adult life would be limited.

Spondylolysis and especially spondylolisthesis has been clinically associated with low back pain. It is perhaps surprising that the risk of low back pain and sciatica is only slightly increased among adults with this defect (Saraste 1987; Virta 1991). This could be different among young people, but no population studies have been published.

**Major trauma.** Major injury of a joint often leads to osteoarthritis (McMurray 1939; Ragnarsson and Mjöberg 1992), and traumatic intervention has been used as an animal model of osteoarthritis (Troyer 1982). On the other hand, the structures of the hip joint are resistant to trauma, and therefore osteoarthritis secondary to acquired injury has been considered rare (Felson 1988). Trauma has proved an important determinant of osteoarthritis of the knee since 1958 (Kelihgen and Lawrence 1958), and this has not been challenged by later studies (Felson 1988; Felson 1990b).

Trauma as the cause of chronic neck pain is well established, in the form of whiplash injuries (Krusen Jr and Krusen 1955; Jackson 1985) and prolapsed intervertebral disc (Kelsey et al. 1984a), but its impact in the general population is unknown. Traumatic back injury increases the risk of subsequent low
back pain (Riihimäki et al. 1989a). One recent population study has demonstrated the importance of non-specific trauma in low back pain (Walsh et al. 1992b).

**Cumulative trauma.** Cumulative trauma is a basic conceptual model of osteoarthritis (Radin et al. 1991) and important also in low back pain (Kumar 1990). Extensive running and stereotypic occupational tasks have been used as operationalisations of the concept (Felson 1990b; Kumar 1990). This solution is probably not altogether appropriate, as the excess risk associated with running is not consistent and not very great (Panush et al. 1986; Marti et al. 1989); running could, of course, also have beneficial effects. No pure operationalisation of cumulative trauma can at this time be used in epidemiological studies, and the model can thus only be investigated indirectly.

**Physical stress at work.** Physically heavy work has been associated with musculoskeletal problems in general (Riihimäki et al. 1985; Riihimäki and Mäkinen 1986; Leino et al. 1988) and with the osteoarthritis in the knee and hip joints, chronic neck pain, low back pain and shoulder problems in particular (Bjelle et al. 1979; Westerling and Jonsson 1980; Herberts et al. 1981; Kelsey et al. 1984a; Kelsey et al. 1984b; Heliövaara 1988; Svensson and Andersson 1989; Walsh et al. 1989; Felson 1990a; Clemmer et al. 1991; Vingård et al. 1991; Croft et al. 1992; Kivimäki et al. 1992). The evidence is weighty. Moving heavy objects, work in twisted postures, focal loading of joints in nonneutral positions and a high accident rate are extremely consistent risk indicators of all these syndromes, in a variety of research designs.

Some studies have come up with negative associations between physically heavy work and some musculoskeletal syndromes (Bergenudd et al. 1988; Biering-Sørensen et al. 1989; Bigos et al. 1992). Also, physical loading by way of leisure–time physical activity seems to be protective (Gyntelberg 1974; Svensson et al. 1983; Riihimäki et al. 1985). This paradox requires some attention. One approach is that work requires constant uninterrupted activity, and that leisure–time activity allows better voluntary control over the performance (Maeda 1977; Wallace and Buckle 1987; Winkel 1989). This interpretation would accommodate the observation that musculoskeletal pain
has increased while the average work load has decreased (Allan and Waddell 1989; Winkel 1989).

Some light on the problem of physical work load and back pain has been shed by the investigation of spinal pathology (Vanharanta et al. 1987b; Videman et al. 1990). Heavy work showed the expected association with spinal degeneration, but excess degeneration of the discs was also seen in subjects with sedentary work.

Physical workload has been measured in very varying ways, from classification of occupational labels (Hult 1954a; Anderson et al. 1962) to classification of job descriptions (Jacobsson et al. 1992) or even videotapes of the actual work performance and EMG measurements (Bjelle et al. 1987; Punnett et al. 1991). Most often physical workload has been estimated by some form of questionnaire (Leino et al. 1988; Felson 1990a; Videman et al. 1990; Vingård 1991), but as there is no universally accepted model of what exactly should be measured, no standard has emerged. When the investigator does not have access to the worker or to job descriptions, such as when doing register-based studies (e.g. Vingård et al. 1991), occupation codes may be used as proxy measures. Various methods for imputing physical (and mental) work load from occupation codes have been used, an example from the sophisticated end of the spectrum being that by Schwartz and coworkers (Schwartz et al. 1988).

Whole body vibration. A specific exposure that has received much attention as a work-related risk factor of musculoskeletal disorders is vibration, especially as related to motor vehicle driving (Kelsey et al. 1984a; Kelsey et al. 1984b; Radin 1987; Bongers et al. 1988a; Bongers et al. 1988b; Heliövaara 1988; Walsh et al. 1989; Bovenzi and Zadini 1992; Pope and Hansson 1992). This seems to be a risk indicator for low back pain, for both lumbar and cervical disc herniations, and possibly also osteoarthritis, and it may exert its effect in a way different from other forms of work load (Pope and Hansson 1992). In a comprehensive epidemiological study it may still be treated as any other work load item, as it is not strikingly stronger than for example lifting, pushing and pulling heavy objects (Heliövaara 1988; Walsh
et al. 1989; Heliövaara 1993), and cannot even always be confirmed as a risk factor (Bongers et al. 1988b).

**Muscle fatigue and physical condition.** As chronic muscle fatigue and tension are a much-used model of explaining musculoskeletal pain to patients (Spitzer et al. 1987; Waris 1979; SBU 1990), one would expect them to be well investigated. However, there are serious difficulties in operationalising the concept (Roy et al. 1989), and therefore only a few epidemiological studies have produced results directly investigating this risk indicator. On the other hand, many of the above-mentioned findings on physical stress at work relate implicitly to muscle fatigue (Maeda 1977), if the stress is not sufficient to cause permanent cumulative damage.

In one study in welders, muscle strength was found to be weaker on the right side, indicating more fatigue (Herberts and Kadedors 1976); this was associated with shoulder problems. Static muscle load and repetitive muscle contractions, consistent with the model of chronic fatigue, have been judged in a meta-analysis to be associated with neck pain of the tension neck type and with rotator cuff tendinitis (Hagberg and Wegman 1987).

Observed muscular tension in the neck in school children has predicted neck pain later in life (Hertzberg 1985), and the association has even been verified in a randomised controlled trial (Klipikari et al. 1990).

An association of muscular or general physical condition and low back pain has often been documented. Leisure-time physical activity or muscle strength has predicted a lower risk of low back pain in several follow-up studies (Gyntelberg 1974; Biering-Sørensen 1984; Biering-Sørensen et al. 1989; Heliövaara 1993), though not always (Hertzberg 1985; Leino et al. 1987; Battie et al. 1989a; Battie et al. 1989b). There is some evidence that muscular atrophy and fibre type affect the risk of low back pain (Kalimo et al. 1989). Intervention studies have shown improved prognosis and reduced risk of recurrence and chronicity with improved muscular condition (Chöler et al. 1985; Manniche et al. 1988; Hazard et al. 1989; Donchin et al. 1990; Rodriguez et al. 1992).
Even osteoarthritis may benefit from an improved physical condition (Kovar et al. 1992). It hardly affects the joint itself, but the impact of joint degeneration does depend on extra-articular features as well. No studies have addressed the question of muscle strength as predictor of osteoarthritis. This is understandable, as the relationship is necessarily complex, time-dependent and confounded by associated factors.

**Body height.** Tall persons have been found to have a higher risk of sciatica or herniated lumbar intervertebral disc (Hrubec and Nashold 1975; Heliövaara 1988; Riihimäki et al. 1989b), but even these findings have not been seen in all other studies (Kelsey et al. 1984b). Body height has not been associated with any other major musculoskeletal disorders.

**Body weight and fat distribution.** Obesity is considered a strong determinant of osteoarthritis of the knees (Davis et al. 1988; Felson 1988; Davis et al. 1989) and a weaker determinant of osteoarthritis of the hips (Felson 1988) and other joints (Kellgren 1961; Kärkkäinen 1985; van Saase et al. 1988). Its role in other musculoskeletal disorders is more in dispute, with conflicting results in epidemiological studies on musculoskeletal problems in general (Aro and Leino 1985), sciatica (Kelsey et al. 1984b; Heliövaara 1988) and low back pain (Biering-Sørensen 1984; Deyo and Bass 1989). No studies are available on the risk of chronic neck pain, shoulder impairments or fibromyalgia associated with obesity.

It has been suggested that obese people have a high risk of generalised osteoarthritis, and that this might be a general metabolic effect (van Saase et al. 1988; Spector and Campion 1989). Body fat distribution and disorders of lipid metabolism, on the other hand, do not differentiate between arthritic and non-arthritic persons (Davis et al. 1990a; Davis et al. 1990b).

An obvious interpretation of the association of obesity and osteoarthritis is that the increased weight places the joint cartilage under excess strain. This is perhaps not completely appropriate (Radin et al. 1991; Vanharanta and Kääpä 1992), the living cartilage can adapt. However, the increased load would also mean increased peak loads affecting more vulnerable parts of the
joint (Swann and Seedhom 1993). In any case, weight loss has been shown to decrease the risk of osteoarthritis of the knees, strongly corroborating the notion of obesity being one cause of the disorder (Felson et al. 1992).

**Smoking.** Smoking has been found to be a risk factor of low back pain and sciatica in both cross-sectional and prospective studies (Svensson et al. 1983; Biering-Sørensen and Thomsen 1986; Battie et al. 1989a; Biering-Sørensen et al. 1989; Deyo and Bass 1989) and herniated intervertebral discs, even in the cervical region (Kelsey et al. 1984a; Kelsey et al. 1984b), and has been associated with degeneration of the intervertebral disc in magnetic resonance images (Battie et al. 1991). It is likely that it plays a part in the process of chronic low back pain, perhaps by jeopardising the nutrition of the disc (Ernst 1993), but its role in other musculoskeletal disorders is less clear. In one study, smoking was more strongly associated with limb pain than back pain (Boshuizen et al. 1993). It seems to protect against osteoarthritis (Felson et al. 1989; Felson 1990a), although this finding requires corroboration from independent studies. The ills of smoking are many – a recent study implicates smoking as a risk factor even in seropositive rheumatoid arthritis (Heliövaara et al. 1993a).

**Education.** The level of formal education has been found to be a determinant of several kinds of chronic musculoskeletal problems. Low back pain (Deyo and Diehl 1988; Deyo and Bass 1989), chronic neck pain (Jacobsson et al. 1992) and osteoarthritis (Pincus et al. 1989; Weinberger et al. 1990; Jacobsson et al. 1992) are all associated with a low level of education. It may be that education covers factors associated with the severity of symptoms within a diagnostic group, as the whole effect of education is not accounted for by adjusting for age, race, obesity, occupational factors or injury (Hannan et al. 1992). It has been suggested that fibromyalgia is paradoxically associated with a high level of education (Cathey et al. 1986).

**Mental characteristics.** There is no back pain personality (Schmidt and Arntz 1987), nor any rheumatic personality (Lahtela and Karttunen 1985). Psychological factors measured in childhood do not predict back or neck pain (Vilkari–Junutula et al. 1991). This does not mean that persons with chronic
musculoskeletal pain have no mental problems; they do (Magora 1973; Joukamaa 1986; Atkinson et al. 1988; Bergenudd et al. 1988; Hawley and Wolfe 1988; Svensson and Andersson 1989; Feyer et al. 1992). It just means that no stable personality trait predetermines that someone will be a chronic back patient and another will not.

Actual mental illness cannot be used as an indicator of a single characteristic subgroup in chronic pain patients (Benjamin et al. 1988; Coste et al. 1992). Mental distress and thereby also mental illness (especially depression) are common among sufferers of musculoskeletal pain (Lahtela and Karttunen 1985; Murphy et al. 1988). There is also no specific form of distress typical for chronic pain patients. Mental symptoms can be seen as indicators that coping with the pain and other vagaries of life has become complicated and difficult (Troup and Slade 1985).

Not only are mental problems overrepresented among persons with musculoskeletal syndromes, they also predict them (Heliovaara 1988; Leino 1989) and their outcome (Hurme and Alaranta 1987; Summers et al. 1988; Barnes et al. 1989; Weinberger et al. 1990; Main et al. 1992). Some data suggest that depression often appears after the onset of the musculoskeletal problem, and certain other mental problems, especially anxiety and substance abuse, could be risk indicators (Gamsa 1990; Atkinson et al. 1991; Polatin et al. 1993).

**Non-physical characteristics of the environment.** Social support (Linton and Kamwendo 1989), social structures and expectations at work (Linton and Kamwendo 1989; Weinberger et al. 1990), discord in social relationships (Hurme and Alaranta 1987; Saarijärvi et al. 1990), and dissatisfaction with one's job (Magora 1973; Wallace and Buckle 1987; Bigos et al. 1992b) are phenomena that have been studied as determinants of musculoskeletal morbidity, but cannot be ascribed to the individual mental structure alone. These psychosocial risk factors have been seen in cross-sectional as well as predictive epidemiological studies and in studies concerning the prognosis of established illness.
Social factors outside the immediate environment of the individual have also been incriminated. Such factors include features of the social insurance system or compensation procedures (Allan and Waddell 1989; Greenough and Fraser 1989), labour market forces (Clemmer and Mohr 1991) or the medical care procedure itself (Hall and Morrow 1988).

That social and cultural factors play a part in musculoskeletal morbidity is hardly in question. The problem lies again in model definition: as the very definition of an illness is a cultural phenomenon (Jensen 1983; Hunter 1991), it is hard to produce comparative study designs that could solve the issue of whether the actual occurrence of an "objective" disorder varies or whether it is "only" a reflection of varying experience.

**Comorbidity.** In a number of studies, an excess of musculoskeletal problems has been observed in persons with other medical conditions (Svensson et al. 1983; Biering-Sørensen and Thomsen 1986; Guralnik et al. 1989; Pincus et al. 1989; Stewart et al. 1989). Also, different musculoskeletal disorders are often seen in the same patients, either simultaneously (Hult 1954b) or emerging during a follow-up period (Jacobs et al. 1990; Rekola 1993). There are common risk factors, especially those associated with limited education, hard work and an unhealthy life style, which may explain much of this comorbidity. It is hard to see how the coexistent disorders could actually cause one another; one exception is diabetes as a suggested cause of disc degeneration (Silberberg 1986).

**C. Disability in chronic musculoskeletal syndromes**

Disability is a consequence of disease or other medical disorder. The nature and severity of disability are simultaneously determined by several medical and non-medical factors (WHO 1980; Cunningham and Kelsey 1984; Patrick 1989).
1. Measures of disability

Disability is a concept encompassing several functional dimensions (Wood and Badley 1978; WHO 1980; Read et al. 1987). Measuring disability has received much attention in epidemiological research in the past twenty years (Fanshel and Bush 1970; Nagi 1976; Wood and Badley 1978; Jette 1980; WHO 1980; Read et al. 1987; Charlton 1989; Abramson et al. 1992), but no standard has emerged and the instruments used by different researchers have only limited comparability.

One reason for the variation in measuring disability is that each unique disability and each of its levels has its own array of causes (Guccione et al. 1990). Therefore, no complete measure of disability or complete model of the causes of disability can exist. The selection of the measure depends upon the purpose of the investigation (Feinstein et al. 1986; Charlton 1989). When the purpose is to compare different disorders, global measures are needed. When describing the impact of one disorder or another, each disorder is best described by limitations of the individual activities most characteristically affected by it (Feinstein et al. 1986).

When estimating the impact of a specific disorder, or of musculoskeletal disorders in general, comorbidity (coexistence of two or more disorders) must be taken into account: disability may be associated with some other coexistent disorder as well as, or rather than, with the one(s) in question. As many medical conditions, including musculoskeletal disorders, share common social and behavioural risk factors, comorbidity confounds the association of any specific disorder and disability (Pincus et al. 1989; Stewart et al. 1989). The same argument applies for several social determinants of disability.

2. Determinants of disability

The past 20 years have bred an increased awareness of musculoskeletal disorders as contributing causes of disability. The increase of work disability
caused by back pain in industrial countries is well documented and far exceeds the increase in other work disability (Waddell 1987a; Allan and Waddell 1989).

The musculoskeletal disorders most likely to have an impact on the level of disability in the population are rheumatoid arthritis, osteoarthritis of the knees, hips, or hands, and spinal disorders, especially chronic low back pain and herniated lumbar intervertebral disc (Kellgren et al. 1953; Bonham 1978; Cunningham and Kelsey 1984; Kelsey and Cunningham 1984; Yelin et al. 1987; Guralnik and Kaplan 1989; Peach 1989; Pincus et al. 1989; Guccione et al. 1990).

Previously suggested non-medical determinants of disability include age, sex (Nagi 1976; Pinsky et al. 1987), education (Nagi 1976; Pinsky et al. 1987; Guralnik and Kaplan 1989; Harris et al. 1989), overweight (Guralnik and Kaplan 1989; Harris et al. 1989; Rissanen et al. 1990; Verbrugge et al. 1991), a physically inactive lifestyle (Mor et al. 1989), and smoking (Pinsky et al. 1987; Guralnik and Kaplan 1989). It is also plausible that a history of physically or mentally heavy work is associated with an increased level of disability, even allowing for their effect on the risk of the disorder itself (Frymoyer 1992). Also at this level, social determinants may be important. Back pain has been found to be more disabling in times and regions of economic hardship (Volinn et al. 1988), regardless of the individual characteristics of the disabled persons.
III. Purpose of this study

The purpose of this study was to

1. analyse what shared and distinct risk indicators can be identified at the population level for the syndromes of chronic low back pain, chronic neck pain, clinically defined osteoarthritis of the hip, and a syndrome of chronic musculoskeletal pain with no definite pathogenic model, the fibromyalgia syndrome (I, II, III, IV).

2. construct a model of the role of chronic musculoskeletal disorders as determinants of disability in the population, and analyse the fractions of this disability attributable to musculoskeletal disorders (V).

3. assess the validity of a hypothesis stating that the individual common musculoskeletal syndromes are closely enough related to warrant a concept of generalised chronic musculoskeletal pain and dysfunction (this report).
IV. Population and methods

A. Population

The data were collected in 1977–1980 as part of the Mini–Finland Health Survey, designed to provide information about the population's health, its need for care and rehabilitation, the consequences of disease, and factors affecting health (Aromaa et al. 1989a).

The study population was a two-stage cluster sample (Kish 1965; Lehtonen and Kuusela 1986). First, 40 areas were selected in regard to geographical area, degree of urbanisation, and proportion of people employed in industry and agriculture. In the second sampling stage, a systematic sample of the inhabitants aged 30 years or more was drawn from the population register of each region.

The resulting sample consisted of 8,000 persons (3,637 men and 4,363 women) and has been shown to be representative of the Finnish population (Lehtonen and Kuusela 1986).

B. Screening and data collection

The examinations were carried out by the Mobile Clinic of the Social Insurance Institution in two main phases, a screening phase and a main examination phase about three months later. In addition, validation samples were studied to investigate the sensitivity of screening and the reliability of diagnostic and other data (Aromaa et al. 1989b; Heliövaara et al. 1993b). The flow of procedures is described in Figure 1.
Figure 1. The flow of operations during the Mini–Finland Health Survey.

**SAMPLING**

Selection of 40 regions;

Sample of population ≥ 30 years of age
N=8,000 (100%)

**SCREENING**

Health interview by local public health nurses; part of the determinant and disability data
N=7,703 (96%)

Screening examination by mobile clinic; questionnaires, symptom interviews and basic measurements
N=7,217 (90%)

**DIAGNOSTIC**

Clinical examination
N=3,434 in musculoskeletal examination
(91% of those invited)

Validation samples
N=339-1,327

weighted sample

FOLLOW-UP examination for musculoskeletal disorders, about 1 year later. N=302.
1. Health interview, basic questionnaire and screening examinations

A total of 7,217 persons (90% of the sample) participated in the whole screening phase. The distributions of sex, age, marital status and level of education among the participants corresponded closely to those in the whole Finnish population (Aromaa et al. 1989a). This is the basic population for all the analyses in this study.

About one month before the screening examination, the subjects were interviewed by public health nurses in their homes or the institutions they were staying at. The interview included questions about the need for help in several key activities. Also, the educational status and family relations were asked at this point.

Together with the invitation to attend the screening examination, the subjects received a questionnaire eliciting information about previous symptoms, diseases, hospitalisations, operations and medications. This questionnaire also included questions about difficulties in performing several standard tasks, about the use of alcohol and tobacco, and about the work history of the person.

In the screening examination, a specific interview for the musculoskeletal system included questions about musculoskeletal pains and disorders, as well as their consequences. It was at this point that information on previous serious accidents to the trunk, the upper limbs or the lower limbs was obtained. In addition, a standardised joint function test was carried out to assess musculoskeletal impairment (Sievers et al. 1985). The ten functions assessed were: walking on level ground, walking on tiptoe, climbing on a step, crouching, abduction of the arm straight up, extension of the elbow, flexion of the elbow, extension of the wrist by pressing the palms together, flexion of the fingers to a fist, and flexion of the thumbs.

Standard symptom interviews, blood pressure measurements, chest X-ray, and electrocardiographic and spirometric examinations were performed to reveal any cardiovascular and respiratory diseases (Aromaa et al. 1985). A
30–item translation of the General Health Questionnaire (Goldberg 1972) on mental symptoms (somatic symptoms were excluded) was used to screen for mental disorders (Lehtinen et al. 1985). Body weight and height were measured in light indoor clothing without shoes. Serum samples were taken and stored at −20°C.

2. **Diagnostic procedure**

A person was considered positive in the screening for musculoskeletal disorders, and invited to the diagnostic examination, if he or she had one or more of the following:

1. Difficult or impossible to perform adequately on one or more of the joint function tests
2. A report in the basic questionnaire of a chronic disorder, diagnosed by a physician, in the back, neck, joints or muscles
3. A report in the interview of musculoskeletal symptoms of chronic pain or stiffness in the back, neck, or joints

or

4. A previous diagnosis of a chronic musculoskeletal disorder found in the registry of disability pensions, or in the registry of diseases entitling to a special refund for medications, of the Social Insurance Institution.

Similar criteria for screening were applied to the other disease groups. Being positive on one screen did not preclude being positive on another.

The main diagnostic examination consisted of three major parts, for which the subjects were screened independently. These parts were the examination for musculoskeletal disorders, the examination for cardiovascular, respiratory and other diseases, and the examination for mental disorders.

Those subjects who, by their screening examination, were considered to have a possible musculoskeletal disorder were examined by one of the eight project physicians according to a standard examination protocol (Sievers et
al. 1985; Aromaa et al. 1989b). The protocol included diagnostic criteria separately for each of the major chronic musculoskeletal disorders. The criteria for diagnosis of a chronic neck pain syndrome are shown as an example in Figure 2; the criteria for other disorders included also serological or radiological components, as appropriate.

Figure 2. The diagnostic criteria for chronic neck pain.
It is worth separate mention that osteoarthritis was diagnosed on clinical grounds only. A symptom history of pain and impairment which the examining physician considered typical of osteoarthritis and the clinical findings of crepitus, bony enlargement and restricted range of movement were the elements of the criteria. No radiologic data were required, although the diagnosis was often supported by earlier radiographs.

Fibromyalgia was not part of the original diagnostic schedule of the Mini–Finland survey. However, it was possible to devise a combination of items from the interview and questionnaire data that approximate the criteria suggested for fibromyalgia (Yunus et al. 1989). A necessary element of the criteria was the presence of widespread longstanding pain. As the condition was not specifically searched for, no observation bias is expected. This devised operational entity of 'fibromyalgia' will be enclosed in single quotes in this report, to emphasise its non–clinical nature.

The examining physician made a judgment as to whether one or more of the current disorders were in any way disabling, i.e., whether they interfered with the subject's ability to run his or her life, as opposed to being just a nuisance.

The examination procedure for cardiovascular, respiratory and other diseases (Aromaa et al. 1985) was also performed by the same physicians. The examination for mental disorders was based on the Present State Examination coded by the CATEGO computer algorithm (Wing et al. 1974). The Present State Examination interview was performed by a nurse specialised in mental disorders.

3. Formation of other variables used in this study

A subject was considered to have a reduced working capacity when he/she had been awarded a disability pension or he/she reported having had to reduce or change work for health reasons. This outcome is relevant only among those 30–64 years of age, as 65 is the general age of retirement in Finland.
The health interview and basic health questionnaire elicited information on whether the person could perform certain functions without difficulty, with marked difficulty, or not at all. Basic activities of daily living included moving about the house, getting in and out of bed and dressing and undressing. Usual activities of daily living included carrying a shopping bag of 5 kg, walking 400 m, climbing a flight of stairs, and managing grocery shopping. Occasional activities of daily living were clipping one's toenails, reading a newspaper, performing heavy housework such as cleaning, and travelling on public transport.

Those with marked difficulty in any of the basic, usual or occasional activities of daily living were considered in need of help at least occasionally. Those who were completely unable to perform any of the basic or usual activities were considered in need of help regularly, at least several times a week (Aromaa et al. 1989a).

The various educational experiences reported by the subjects were classified into five categories, corresponding to the Finnish educational system current at the time the subjects had studied. These levels were: 1. less than elementary school (less than 6 years), 2. elementary school (approximately 6 years), 3. secondary school and/or some vocational training (approximately 6–11 years), 4. gymnasium and/or vocational college (approximately 10–14 years) and 5. university training (over 12 years). To reduce the number of categories in some analyses, groups 2 and 3 were combined and so were groups 4 and 5.

A history of traumatic injury was elicited during the screening interviews, separately for the back and neck, upper limbs and lower limbs. A traumatic injury was defined as any sudden, unexpected forceful event leading acutely to a period of pain and disability.

The present occupation, or the last occupation of pensioners, was classified according to the Nordic classification of occupations (Pohjoismainen ammattiluokittelu 1963), an adaptation of the International Labour Organization's standard classification (Brockington 1967).
The presence of physically stressful features – lifting heavy loads, work in a twisted posture, continuous standing, vibration, repetitive movements, and work paced by a machine – in the present occupation or in the previous occupation of longest duration, as reported in the basic questionnaire, were recorded as dichotomies (no=0, yes=1) and summed to form an index of physical stress at work. The self-reported mentally stressing features – uninteresting or monotonous work, a hurried or tight work schedule, and worry about making mistakes – were recorded at three levels of severity (none=0, mild=1, severe=2) and summed to form an index of mental stress at work.

The Body Mass Index was calculated by the formula weight/height² (kg/m²).

C. Statistical methods

For most analyses searching for an association between a risk indicator and outcome, logistic regression modelling was used (McCullagh and Nelder 1983). In one case (V), a proportional odds logistic regression model was fitted to assess whether a multi-level approach was appropriate (McCullagh 1980). Also, the proportional hazards model of survival (Cox 1972) was used in some analyses (IV), where a follow-up design was created by linkage with the Finnish death registry.

The selection of variables for a model was made examining the statistical effect of the variable on the model, i.e. tested by the likelihood ratio test, but rigid numeric criteria were not used. The judgment of the inclusion depended on the other variables in the model; if several variables were alike in their logical relation to the end point, they were included or excluded as a group. Also, in related analyses, such as on the determinants of three manifestations of disability, the goal was to use the same variables in all models (V).

The inclusion of second-order terms, i.e. quadratic terms (a non-linear relationship between risk indicator and outcome) or first-order interactions (effect modification), was judged individually for each analysis; the criterion
was the likelihood ratio. In some cases, a stratified analysis by age or sex was considered more informative.

For estimating attributable fractions, a model–based approach was used (V). This avoided the pitfalls of (a) applying the usual formula, which, when approximating the risk ratio by the odds ratio, assumes small prevalences, and (b) ignoring the covariance between the determinants in the model.

The model–based approach is an application of the covariance adjustment procedure suggested by Lee (Lee 1981). The procedure consists of calculating the individual estimated risk functions for each individual from the logistic regression equation

$$P_i = \frac{1}{1 + \exp(-\alpha + \beta' x_i)}$$

(1)

where \( P_i \) is the probability of a positive response in the endpoint variable, \( \alpha \) the intercept parameter and \( \beta' \) the vector of the slope coefficients associated with the vector \( x_i \) of the all risk factor scores in the model (SAS 1989). Then, again for each individual in the original population, the vector \( x_i' \) of the risk factors whose attributable fraction is to be estimated is set to the reference value (usually 0) and the risks \( (P_i') \) estimated again. Now, if the model is appropriate, this should reflect the individual risks in a population where the risk factors of interest are eliminated. The attributable fraction, being the difference in the average risk achieved by the hypothetical elimination of the risk factor, is, naturally,

$$AF = \frac{\sum (P_i - P_i')}{\sum P_i} \times 100\%.$$ 

(2)

The reliability of the measurements on interval scales was assessed by the intraclass correlation coefficient \( R \) (Winer 1971), and specifically by the kappa statistic (Fleiss 1981) in the case of dichotomous measurements.
D. Validation of data

To assess the sensitivity of screening, a sample of subjects were invited to the main diagnostic examination regardless of their screening status. This revealed that the sensitivity of the screening was good or adequate (80–100%) for all chronic musculoskeletal disorders (Heliövaara et al. 1993b).

A repeat testing of the joint functions used in the screening procedure was performed on 794 subjects about 3 months later (at the time of the main examination); the kappa coefficients ranged from 0.36 to 0.76 (Heliövaara et al. 1993b).

The variation between the examining physicians in the use of the diagnostic criteria was assessed by a set of forty authentic subject documents, reassessed twice by six of the eight examiners over an interval of one year. The overall agreement (kappa) ranged from 0.58 (shoulder joint disorder) to 0.87 (inflammatory polyarthritis) (Heliövaara et al. 1993b).

The stability of the musculoskeletal disorders over time was assessed about one year after the main examination by a follow-up examination performed by a specialist in physical medicine. The diagnostic threshold was quite different (as were the diagnostic criteria) in the two examinations, the follow-up examination being much more sensitive. The overall agreement (kappa) between the two was, at worst 0.22 (shoulder joint disorder), at best 0.58 (osteoarthritis) (Heliövaara et al. 1993b).

Among those subjects who participated in the clinical examination, the convergent validity of the disability measures was assessed by comparing the self-reported disability against physician-assessed working ability and overall disability. For reduced working capacity, kappa was 0.62; for at least occasional need of help (against at least marked general disability) kappa was 0.51; and for regular need of help (against almost complete or complete general disability) kappa was 0.42 (V).
Random samples (n=339 to 1,327) of the subjects repeated the examinations for background variables during the main examination. The reliability statistics for age, sex, education, occupational class, smoking, body mass index and parity were between 0.80 and 1.00. The intraclass correlation coefficient R for the index of physical stress at work was 0.66; for mental stress, it was 0.60 (II).
V. Results

A. Prevalence of common musculoskeletal syndromes

The prevalence of low back pain and sciatica was studied among persons 30–64 years of age (I, Table 1). A clinical diagnosis of non-sciatic low back pain was used in 11.6% and one of sciatica in 5.1% of this population. There was a definite increase in prevalence with advancing age in this age group, but no sex difference.

A chronic neck pain syndrome was diagnosed in 9.5% of men and 13.5% of women in the whole study population aged 30 years or more (II, Table 1). The age distribution showed an increase up to the age of 55–65 years, after which the prevalence declined. The sex difference was significant.

Osteoarthritis of the hip joint was diagnosed in 4.1% of men and 6.0% of women in the total study population (III, Table 1). The prevalence was very low in those younger than 45 years and showed a sharp increase with advancing age.

'Fibromyalgia', according to the operational criteria devised for this study, was diagnosed in 0.75%, with a female preponderance and a peak prevalence at the age of 55–64, an occurrence profile similar to that of chronic neck pain (IV, Table 1).
B. Risk indicators of common musculoskeletal syndromes

1. Education

A low level of education was associated with a high prevalence of chronic neck pain and 'fibromyalgia' (II; IV). In the former case, the association was confounded by work-related stresses, both physical and mental, but this was not the case with 'fibromyalgia'. A confounded association with a low level of education has been found in the same survey for low back pain (but not sciatica) in men and with osteoarthritis of the hip and knee joints, but it was not specifically searched for in the analyses of this report (data not shown).

2. Physical stress at work

A sum index of physically heavy work, based on the occupation of longest duration, was seen to be strongly and consistently (across syndromes and population strata) associated with low back pain, sciatica, chronic neck pain, unilateral and bilateral osteoarthritis of the hip and with 'fibromyalgia' (I–IV; Table 1). The strength of the association varied somewhat, being weaker for sciatica than other low back pain (I) and even losing statistical significance for 'fibromyalgia' in a multivariate analysis (IV). In spite of this variation, the association affected all the common musculoskeletal syndromes, with an effect proportional to the number of stress items.

3. History of trauma

A history of injury to the afflicted body region was strongly associated with sciatica, other low back pain, chronic neck pain and unilateral hip osteoarthritis, with a weaker association with bilateral hip osteoarthritis (I–III; Table 1). The association persisted after multivariate adjustment for age, sex, physical stress at work and various syndrome-specific risk indicators.
4. Mental stress at work

Occupational mental stress was associated with sciatica, other low back pain and chronic neck pain (I; II; Table 1). The association was proportional to the number of items reported, and was observed for chronic neck pain even among those over 65 years of age, i.e. retired people. It was not observed for ‘fibromyalgia’ and it was not analysed for hip osteoarthritis (III; IV).

5. Overweight

Being overweight had a strong and consistent association with bilateral hip osteoarthritis, and a weaker one with unilateral osteoarthritis (III; Table 1). It was weakly (and nonlinearly) associated with chronic neck pain and it had no consistent association with sciatica, other low back pain or ‘fibromyalgia’ (I; II; IV).

6. Body height

Body height was a risk indicator only for sciatica, and even this association was inconsistent in an analysis stratified by age and sex. Even though the overall association was significant, after stratification it could only be seen among men over 50 years of age (I, Table 3).

7. Smoking

Smokers had a somewhat higher risk than non-smokers for chronic neck pain in the working-age population (II, Table 2), but the association was confounded by other risk indicators. The association of smoking with sciatica was not significant, but that with other low back pain persisted even after multivariate adjustment (I, Table 2). However, this association varied substantially between age and sex groups, and was not seen among women under 50 years of age (I, Table 4). Smoking was not associated with ‘fibromyalgia’ (IV).
Table 1. Some risk indicators of syndromes of chronic musculoskeletal pain. Odds ratios and 95% confidence intervals based on logistic regression models adjusting for age, sex and all other risk indicators significant for the condition (I, II, III).

<table>
<thead>
<tr>
<th></th>
<th>Non-sciatic low back pain (Age 30–64)</th>
<th>Sciatica (Age 30–64)</th>
<th>Chronic neck pain (Age 30–64)</th>
<th>Bilateral hip osteo–arthritis</th>
<th>Unilateral hip osteo–arthritis</th>
</tr>
</thead>
<tbody>
<tr>
<td>History of trauma to painful body region</td>
<td>2.5 (2.0–3.0)</td>
<td>2.4 (1.9–3.2)</td>
<td>2.0 (1.6–2.4)</td>
<td>1.5 (0.9–2.3)</td>
<td>2.1 (1.4–3.1)</td>
</tr>
<tr>
<td>Sum index of physical stress at work; referent level 0^*^</td>
<td>1.2 (0.9–1.6)</td>
<td>1.6 (1.1–2.3)</td>
<td>1.3 (1.2–1.3)</td>
<td>1.4 (0.8–2.3)</td>
<td>1.1 (0.7–1.8)</td>
</tr>
<tr>
<td>1</td>
<td>1.2 (0.9–1.6)</td>
<td>1.6 (1.1–2.3)</td>
<td>1.3 (1.2–1.3)</td>
<td>1.4 (0.8–2.3)</td>
<td>1.1 (0.7–1.8)</td>
</tr>
<tr>
<td>2</td>
<td>1.7 (1.3–2.1)</td>
<td>1.9 (1.3–2.6)</td>
<td>1.6 (1.4–1.8)</td>
<td>2.2 (1.5–3.4)</td>
<td>1.5 (1.0–2.3)</td>
</tr>
<tr>
<td>3</td>
<td>2.1 (1.6–2.7)</td>
<td>1.9 (1.2–2.8)</td>
<td>2.0 (1.6–2.6)</td>
<td>2.8 (1.6–4.7)</td>
<td>2.4 (1.4–3.8)</td>
</tr>
<tr>
<td>4 or 5</td>
<td>3.2 (2.3–4.5)</td>
<td>2.0 (1.2–3.4)</td>
<td>2.5 (1.9–3.1)</td>
<td>2.9 (1.5–5.8)</td>
<td>2.3 (1.2–4.3)</td>
</tr>
<tr>
<td>Sum index of mental stress at work; referent level 0^*^</td>
<td>1.2 (1.0–1.5)</td>
<td>1.1 (0.8–1.5)</td>
<td>1.2 (1.1–1.3)</td>
<td>1.1 (0.7–1.8)</td>
<td>1.1 (0.7–1.8)</td>
</tr>
<tr>
<td>1</td>
<td>1.2 (1.0–1.5)</td>
<td>1.1 (0.8–1.5)</td>
<td>1.2 (1.1–1.3)</td>
<td>1.1 (0.7–1.8)</td>
<td>1.1 (0.7–1.8)</td>
</tr>
<tr>
<td>2</td>
<td>1.3 (1.0–1.7)</td>
<td>1.4 (1.0–1.9)</td>
<td>1.4 (1.3–1.6)</td>
<td>1.4 (1.3–1.6)</td>
<td>1.4 (1.3–1.6)</td>
</tr>
<tr>
<td>3 (or more)</td>
<td>2.0 (1.1–1.9)</td>
<td>2.0 (1.4–2.9)</td>
<td>1.7 (1.4–2.1)</td>
<td>1.7 (1.4–2.1)</td>
<td>1.7 (1.4–2.1)</td>
</tr>
<tr>
<td>Obesity (Body Mass Index); referent level &lt; 25^*^</td>
<td>1.4 (1.0–1.8)</td>
<td>1.5 (1.1–2.2)</td>
<td>1.4 (1.0–2.0)</td>
<td>1.4 (1.0–2.0)</td>
<td>1.4 (1.0–2.0)</td>
</tr>
<tr>
<td>25–29.9</td>
<td>1.1 (0.9–1.3)</td>
<td>1.1 (0.8–1.4)</td>
<td>1.5 (1.0–2.3)</td>
<td>2.3 (1.5–3.5)</td>
<td>1.6 (1.0–2.5)</td>
</tr>
<tr>
<td>30–34.9</td>
<td>1.4 (0.8–2.3)</td>
<td>2.8 (1.4–5.7)</td>
<td>1.2 (0.5–3.0)</td>
<td>1.2 (0.5–3.0)</td>
<td>1.2 (0.5–3.0)</td>
</tr>
</tbody>
</table>

^* When marked by asterisk the index was used as an interval–scale variable and odds ratios were imputed.
8. Parity

The number of childbirths was significantly and proportionately associated with chronic neck pain (II, Table 2) among women of working age population, but not among the elderly. The association was not seen for other disorders.

C. Comorbidity

Comorbidity between the different chronic musculoskeletal pain syndromes was striking (I–IV). When regressing the risk of low back pain in those aged 30–64 to age, sex, shared determinants and comorbidity (I, Table 5), the odds ratio of low back pain associated with osteoarthritis was 5.3 (95% confidence interval 4.1–6.9) and that associated with other disorders except osteoarthritis was 3.8 (3.1–4.7). When regressing chronic neck pain in all age groups on similar determinants (II, Table 3), the odds ratio associated with low back pain was 4.3 (3.7–5.2) and those with osteoarthritis of the knees and hips 1.6 (1.3–2.1 and 1.2–2.2). This tendency to comorbidity did not extend to inflammatory joint disorders.

The result of the comorbidity tendency in the population is graphically depicted in Figure 3, in which the area of each overlap is proportional to the population group with one, two or three disorders. The group with all three disorders (low back pain, chronic neck pain and osteoarthritis of the knees or hips) is 1.2% of all those aged 30–64, which is 11 times that expected by the marginal frequencies alone. In those aged 65 or more, the prevalence of all three syndromes at once is 3.9%, 5.2 times that expected by chance alone.

A high prevalence of mental disorders was observed among subjects with fibromyalgia, chronic neck pain, sciatica and non–sciatic low back pain (I; II; IV). After adjustment for shared determinants, the association with chronic neck pain and non–sciatic low back pain persisted, but not so with sciatica (I; II).
Figure 3. A diagram of the sets of subjects with non-sciatic low back pain (LBP), chronic neck pain (CNP) and osteoarthritis of the knees or hips (OA), separately and together.

**Age 30-64**

- CNP and OA 2.9%
- OA 8.0%
- OA and LBP 2.6%
- CNP 11.7%
- LBP 11.6%
- CNP and LBP 4.4%

**Age 65 or more**

- OA and LBP 9.7%
- OA 32.5%
- CNP 13.3%
- LBP 17.3%
- CNP and OA 7.4%
- CNP and OA and LBP 3.9%
- CNP and LBP 6.1%
Diabetics had an unexpectedly low prevalence of non–sciatic low back pain, and the apparent protective effect was enhanced by adjustment for shared determinants (I, Table 5). In such a regression model, the odds ratio associated with diabetes was 0.4 (0.3–0.8). A similar, but statistically not significant, risk reduction was seen for sciatica (I, Table 5), with an odds ratio of 0.8 (0.4–1.6). The effect was not observed (with statistical significance) for chronic neck pain (II, Table 3).

Cardiovascular and respiratory disorders were slightly more common among subjects with chronic neck pain or low back pain, but the associations were confounded by shared risk indicators (I, Table 5; II, Table 3).

D. Disability

1. Musculoskeletal disorders and disability

Disability of all kinds – working disability as well as the need for help in daily or occasional activities – was very common among subjects in whom any musculoskeletal disorder was diagnosed and considered severe enough to be possibly disabling (V, Table 3).

In univariate analyses and those adjusting for age and sex only, all musculoskeletal disorders were significantly associated with reduction in working capacity and the occasional need for help; the same was not true when the risk indicators of regular need for help were investigated. In the latter analysis, chronic low back pain and osteoarthritis of the knee were relatively weak risk indicators, while inflammatory arthritis and osteoarthritis of the hip carried a high risk. These conditions also carried the highest risks of other forms of disability (V, Tables 5 and 6; Table 2).

Low back pain was a major indicator of the risk of reduced working capacity, and when considering this outcome, chronic neck pain also emerged with an increased risk (V, Table 5; Table 2). Osteoarthritis of the hands was only weakly associated with any kind of disability.
Table 2. Logistic regression models of the determinants of disability, including age, sex, non-medical determinants and musculoskeletal as well as other disorders. Odds ratios (OR) and 95% confidence intervals (CI).

<table>
<thead>
<tr>
<th>Age 30–64</th>
<th>Reduced working capacity</th>
<th>Occasional need for help</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disorder</td>
<td>OR (95% CI)</td>
<td>OR (95% CI)</td>
</tr>
<tr>
<td>Inflammatory arthritis</td>
<td>20.8 (11.4–37.7)</td>
<td>9.5 (5.8–15.6)</td>
</tr>
<tr>
<td>Osteoarthritis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– of knee</td>
<td>1.8 (1.2–2.7)</td>
<td>1.8 (1.2–2.5)</td>
</tr>
<tr>
<td>– of hip</td>
<td>7.4 (3.9–14.1)</td>
<td>3.6 (2.2–6.0)</td>
</tr>
<tr>
<td>– of hands</td>
<td>1.5 (0.9–2.8)</td>
<td>1.0 (0.6–1.7)</td>
</tr>
<tr>
<td>Chronic low back pain</td>
<td>6.2 (4.8–8.0)</td>
<td>3.9 (3.1–5.0)</td>
</tr>
<tr>
<td>Chronic neck pain</td>
<td>2.2 (1.6–3.2)</td>
<td>1.2 (0.8–1.6)</td>
</tr>
<tr>
<td>Shoulder joint disorder</td>
<td>1.7 (1.0–2.7)</td>
<td>1.5 (0.9–2.4)</td>
</tr>
<tr>
<td>Other musculoskeletal disorder</td>
<td>1.8 (1.0–3.5)</td>
<td>1.5 (0.8–2.6)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age 65 or more</th>
<th>Occasional need for help</th>
<th>Regular need for help</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disorder</td>
<td>OR (95% CI)</td>
<td>OR (95% CI)</td>
</tr>
<tr>
<td>Inflammatory arthritis</td>
<td>9.5 (5.8–15.6)</td>
<td>5.6 (2.8–1.2)</td>
</tr>
<tr>
<td>Osteoarthritis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– of knee</td>
<td>1.8 (1.2–2.5)</td>
<td>1.5 (1.0–2.2)</td>
</tr>
<tr>
<td>– of hip</td>
<td>3.6 (2.2–6.0)</td>
<td>2.1 (1.4–3.3)</td>
</tr>
<tr>
<td>– of hands</td>
<td>1.0 (0.6–1.7)</td>
<td>1.2 (0.7–2.0)</td>
</tr>
<tr>
<td>Chronic low back pain</td>
<td>3.9 (3.1–5.0)</td>
<td>1.2 (0.7–1.9)</td>
</tr>
<tr>
<td>Chronic neck pain</td>
<td>1.2 (0.8–1.6)</td>
<td>0.9 (0.4–1.8)</td>
</tr>
<tr>
<td>Shoulder joint disorder</td>
<td>1.5 (0.9–2.4)</td>
<td>1.0 (0.5–1.9)</td>
</tr>
<tr>
<td>Other musculoskeletal disorder</td>
<td>1.5 (0.8–2.6)</td>
<td>3.0 (1.3–6.9)</td>
</tr>
</tbody>
</table>

2. Effect of comorbidity

When adjusting for comorbidity, the odds ratios associating inflammatory arthritis with reduced working capacity, occasional need for help or regular need for help increased with increasing complexity of the models. This contrasts with what happened to the odds ratios of the other musculoskeletal disorders – they usually tended towards unity. An exception was seen in the models for reduced working capacity and the occasional need for help
among the working age population, in which chronic low back pain retained
the odds ratios of 6.2 and 4.0, respectively, in the face of any added covari-
ates (V, Table 5).

Comorbidity adjustment removed the significance of chronic neck pain,
shoulder joint disorders, osteoarthritis of the hands and "other" musculo-
skeletal disorders from the models of occasional need for help, thus empha-
sising the effects of the more severe disorders of back pain and especially
osteoarthritis of the hips and knees (V, Tables 5 and 6).

3. Effect of non-medical determinants of disability

The non-medical determinants of disability were to some extent the same
ones that have been considered risk indicators of musculoskeletal morbidity.
People with a low level of education, a history of physically heavy work and
with excessive body weight, as well as excessively thin people, had, in
addition to the increased prevalence of these disorders, an increased risk of
all forms of disability – their disorders had a worse effect on their lives (V,
Table 4).

Adjustment for the non-medical determinants of disability did not materially
affect the risks carried by the disorders themselves. No interaction effects
were seen (V, Tables 5 and 6).

4. Population attributable fractions

In the analysis of determinants of disability, model-based attributable frac-
tions were estimated in addition to odds ratios. The results of this analysis
emphasise the importance of the more prevalent conditions, low back pain
and osteoarthritis of the knees. Osteoarthritis of the hips also stands out as
a major public health problem, receiving an attributable fraction of 7.4% of
the regular need for help among the elderly. Among the working age popula-
tion, no musculoskeletal disorder comes even close to the attributable
fraction of chronic low back pain as determinant of reduced working capacity (10.1%) and occasional need for help (12.6%); this disorder is of far less importance among the elderly (I).

Taken as a whole, the chronic musculoskeletal disorders account for about 20% of all forms of disability among the population, and even more when the aggravating effects of low education, heavy work and overweight are not adjusted for (I, Tables 6 and 7).
VI. Discussion

A. Methods

1. Study design

The study was done on the Mini–Finland Health Survey database, which is a cross-sectional prevalence survey including a clinical examination and standardised diagnostic criteria in a population screened for possible musculoskeletal disorders (Aromaa et al. 1989a). A sample of the screening–negatives was also examined. This approach is exactly what has been suggested as optimal for health examination surveys on musculoskeletal disorders (Bennett 1983). The cross-sectional nature of the data acquisition prevents a direct conclusion about the time order of risk indicator and outcome occurrence (Hill 1965). It also introduces an increased possibility of errors into the risk indicator measurements: several kinds of biases are recognised (Sackett 1979) in addition to random inaccuracy.

Cause must precede effect, and epidemiological designs in which the time order between risk indicator and outcome is known are more persuasive. However, this is but one of the criteria used to assess the weight of the evidence (Hill 1965). When the outcome condition is chronic or episodic and causation is composite, i.e. several causes all have an effect on the occurrence of the same outcome (Wood 1986; Koopman and Weed 1990), even time order is not strictly necessary. It is possible that the determinant of interest has a true effect but the outcome has already manifested itself earlier on the basis of the other causative factors. Therefore, a cross-sectional design is not necessarily inferior to a prospective one in the domain of chronic musculoskeletal syndromes.

A final conclusion about the causality of various associations observed in epidemiological studies is usually possible only when the effect withstands
attempted refutation in a variety of study designs (Hill 1965). In particular, interventions that modify the risk factor should also result in a modified outcome occurrence. This ultimate criterion is, however, often unattainable, and provisional conclusions are used on the basis of various observational studies (Hill 1953). In this context, this study undoubtedly has a valid status.

When studying the effects of various illnesses as determinants of disability, the problem of time order is even less pressing. Even though impairment and disability are defined as consequences of disease (Wood and Badley 1978; WHO 1980), there is no necessity for a time lag between the two, and some degree of disability can even precede the disease – a clear instance of the composite causation referred to above.

2. Validity of case definitions

The distinction of a case from a non-case is an essential element of studying the epidemiology of disease (Miettinen 1985). This distinction is a historically determined cultural line, and reflects the way different disorders are conceptualised at different times (Jensen 1983; Wood 1986). This fact makes even studies of prevalence difficult to compare over time and culture barriers, and the risks associated with different determinants are even more vulnerable to these changes.

In the musculoskeletal disorder study of the Mini–Finland Health Survey, an early decision was made to use broad and descriptive diagnostic categories, such as sciatica, low back pain, and osteoarthritis, with no distinction based on presumed causation (Sievers et al. 1985). This approach has later been recommended by other investigators (Wood 1986; Spitzer et al. 1987), and as the composition of these diagnostic categories is not adequately defined even now (Dieppe 1990; Heliövaara 1993), it seems entirely appropriate.

Osteoarthritis is usually defined for epidemiological purposes according to radiological criteria (Davis et al. 1988; Felson 1988; Felson et al. 1989; Croft et al. 1990). In this study, the diagnosis did not require radiological criteria,
which makes the entity studied quite different from that used in many other studies. However, clinical definitions can be well justified (Croft 1990). Research concerning clinically defined osteoarthritis is relatively scarce and definitely needed (Hadler 1992).

An essential element of validity is reliability (Ware et al. 1981). In the Mini–Finland Health Survey, special attention was paid to the reliability of the diagnostic procedure. A reassessment by six of the project physicians of a set of forty subject documents, including notes on the symptom history and on the physical findings, showed that the overall reliability of the diagnostic decisions was adequate, with a kappa less than 0.60 only in the category of shoulder joint disorder (Heliövaara et al. 1993b).

The screening was efficient (sensitivity 85–100%), and no correction for cases missed in the screening was considered necessary.

There is nothing inherently invalid in estimating disability by interview and questionnaire methods, but the reliability of such measurements is seldom reported (Ware et al. 1981; Read et al. 1987). The measures of disability were compared to a "reference evaluation" that was conceptually not identical: it was performed about three months later, in a different setting, by one of seven experienced and specially trained field physicians. The questions to be assessed were themselves not identical. The physician assessments could not be used as outcome variables, to ensure the independence of the determinant and outcome measurements. The agreement found between physician–evaluated disability and self–reported disability was acceptable especially considering the conceptual discrepancy (V).
3. Risk indicator measurement

Bias and unreliability in risk indicator measurement are problems that are known to affect retrospective studies more than prospective ones, because ill and well people exhibit differential recall and interpretation of risk indicators (Sackett 1979; Schlesselman 1982; Miettinen 1985).

In the present study, the very extent of the primary questionnaire and interview protocols reduces the probability that recall and reporting are disproportionate among those with and those without a specific diagnosis. Such observation bias is further reduced by the separation of the screening phase (during which the risk indicator data were obtained) from the diagnostic phase, in person and place as well as time.

Imprecision in the measurement of risk indicators tends, in univariate analyses, to produce risk estimates closer to the null value (in the case of odds ratios, towards unity) but can in multivariate analyses bias the estimate either up or down (Rosner et al. 1990; Phillips and Smith 1991). When a precise estimate of an effect is needed, much effort should be expended to ensure precise measurement of the risk indicator. In this study, specific training of the interviewers and other quality assurance measures were undertaken to reduce variability in recording (Aromaa et al. 1989b). Most of the reliability estimates were excellent. However, the reporting of physical and mental stress at work carried some error. Therefore, the odds ratio estimates in the models including work stress should be treated with a certain degree of caution.

4. Modeling

In most cases, the statistical association between a risk indicator and an outcome was analysed by logistic regression modeling. This procedure assumes a multiplicative relation between the odds of the outcome on one hand and a linear combination of risk indicators and confounders on the other, and reflects the associations as odds ratios. It is widely used in
epidemiological studies because of its nice properties: it performs equally well with outcome probabilities close to 0 and to 0.5, it is not strict in its assumptions about the distribution of the determinants (McCullagh and Nelder 1983), and it is available in user-friendly computer packages. When the outcome is not rare, as in this study, a word of caution is in place when interpreting the odds ratios. In this case the odds ratio does not approximate the rate ratio. It is not correct to state that if you are grossly overweight, your risk of having bilateral osteoarthritis of the hips is three times what it would be were you thin — it is your odds that are multiplied. The rate ratio is somewhat smaller. This caution only concerns interpretation, it does not mean that the model is invalid.

The application of the logistic regression model to estimate population attributable fractions is less widely used. There are two good reasons for this. First, although the application was suggested some time ago (Lee 1981), the statistical properties of the estimate have not been properly investigated. Second, no commercial computer software exists for the estimation. The second obstacle can be overcome, as has been done in the present study, by some ad hoc programming. As to the first, some information can be derived from a previous report using the approach to modeling the effect of proposed public health interventions on the incidence of heart disease (Kinlay et al. 1992). In that report, empirical data suggested that it is better to combine the effects of two or more different proposed changes in risk factor status by multiplication than by addition. This means that the fractions of disability attributable to osteoarthritis, inflammatory arthritis and low back pain may not simply be added to obtain the combined effect of all these conditions. Rather, the complete estimation procedure should be done hypothetically eliminating the effect of all these conditions simultaneously. In fact, the result is expected, as logistic regression modeling is inherently a multiplicative model.
B. Prevalence of chronic musculoskeletal pain syndromes

The prevalence rates of different musculoskeletal disorders found in the Mini–Finland Health Survey are plausible when compared with other reports of prevalences of similar conditions in other studies (Keilgren et al. 1953; Anderson and Duthie 1963; Viikari–Juntrua 1983; Cunningham and Kelsey 1984; Felson et al. 1987; Hagberg and Wegman 1987; Carman 1989; Deyo and Bass 1989; Hochberg et al. 1989; Jacobsson et al. 1989), and lower than some obtained from special–purpose questionnaire studies concentrating on symptom history (Anderson 1984; Riikhimäki et al. 1985; Hedberg 1988; Svensson et al. 1988).

The one disorder whose prevalence rate raises comment is 'fibromyalgia' (IV). While it has been named one of the most common rheumatic disorders (Campbell et al. 1983; McCain and Scudds 1988) and its prevalence has been quoted at about 10% of women aged 20–49 in a community in Norway (Forseth 1992), our operational criteria put the prevalence at only 0.75%, with almost no cases in those under 50 years of age. One other population study in Sweden came up with the approximately similar prevalence of 1% (Jacobsson et al. 1989). The wide variation is hardly due to true differences in prevalence – the populations of southern Norway, southern Sweden and Finland are not so different. It is more likely that our criteria excluded most of the persons who in the Norse study would have been diagnosed with fibromyalgia. The written criteria are not so dissimilar that the difference could have been predicted on their basis alone. One could suspect excessive sensitivity in studies searching specifically for fibromyalgia: one sees what one expects to see. This sensitivity to interpretations of diagnostic criteria can be seen as a refutation of the very concept of fibromyalgia as a distinct syndrome, although not of the phenomenon of widespread unexplained musculoskeletal pain.
C. Risk indicators

**Education.** The level of formal education was found to be inversely associated with several musculoskeletal disorders (I–IV; Heliövaara et al. 1993b). In most cases, i.e. chronic neck pain, low back pain and osteoarthritis, the risk estimate was reduced to a non-significant level when other risk indicators such as work stress, history of trauma and obesity were included in the models. This suggests that education is a powerful proxy indicator of several causal determinants of these disorders.

In the case of 'fibromyalgia', limited education was the strongest determinant of the condition, with no cases among those with the highest levels of education (IV). The association was not accounted for by differences in work or lifestyle variables. This may suggest that the risk of this condition is affected by other mechanisms than the ones determining chronic neck pain, low back pain or osteoarthritis. A similar association with low education has been found in one previous study (Jacobsson et al. 1992) but contradicts the findings of other studies (Cathey et al. 1986; Forseth 1992).

**Physical stress at work.** In this study, the amount of physical stress at work was estimated by the self-reported presence of various physical features in either the present (or in pensioners, the last) occupation or in the occupation of longest duration. This measure was found to have a graded ("dose-response") relationship to the risk of chronic neck pain, low back pain and osteoarthritis, even after adjustment for all other putative risk indicators (I–III). This is compatible with a causal association.

What must be borne in mind is that the outcome in the present study was a clinical condition, i.e. a symptomatic illness. A finding of a strong, consistent and graded association does not specify the point of the illness process (Jensen 1983) at which the effect takes place. Stress could intensify the symptoms arising from a given degree of biological damage, or it could actually cause the damage. In the present study design, there is no way to distinguish the two effects, but the finding that education was a stronger
determinant of disability than work stress (adjusting for illness) suggests that there is an effect of physical work stress on the degree of damage, not just on its symptoms.

Heavy work has been in several studies associated with spinal degenerative changes (Riihimäki et al. 1989c; Waldron and Cox 1989; Videman et al. 1990) and radiological osteoarthritis (Felson 1990a; Croft et al. 1992), not only chronic or acute musculoskeletal symptoms. This too supports the notion that physical work stress exerts (part of) its effect at the biological stage of the syndrome.

'Fibromyalgia' was not associated with physical stress at work (IV).

**Mental stress at work.** Psychosocial working conditions have often been considered determinants of the variation in the disability or symptoms caused by musculoskeletal disorders (Deyo and Diehl 1988; Lee et al. 1989; Linton and Kamwendo 1989; Feyer et al. 1992; Frymoyer 1992; Hannan et al. 1992), and they have even been found to be predictors of first-time back problems (Gyntelberg 1974; Heliövaara et al. 1987; Leino 1989). In this study, mental stress at work was an independent determinant of the diagnosis of chronic neck pain and low back pain with and without sciatica. If the association is considered causal, the problem remains of where the point of action is in the disease process. This study also cannot determine whether the direction of causation is from disease to distress or vice versa, or perhaps both ways.

**History of trauma.** Reported injury to the back is strongly associated with chronic low back pain, reported injury to the neck, back or arm is associated with chronic neck pain, and injury to the lower extremity is associated with osteoarthritis of the hip (I–III). Even though this risk indicator is subject to a recall bias, it seems likely that it is also a true cause of the conditions. The strongest argument for this conclusion comes from the differential association to unilateral and bilateral osteoarthritis of the hip (IV), which has previously been seen in studies of knee osteoarthritis (Davis et al. 1989). Also, the strength of the association speaks for a true effect.
Body height and weight. Tall persons have been found to have an increased risk of sciatica and herniated lumbar intervertebral disc in some studies (Hrubec and Nashold 1975; Hellövaara 1987; Riihimäki et al. 1989b) but not in others (Kelsey et al. 1984b). In this study, the association of sciatica, but not other low back pain, persisted after adjustment for other known risk indicators, but the magnitude of the effect was small (I). The specificity of the association speaks for causation, but the inconsistency across study populations and the weakness of the association speak against it.

Obesity is a consistent and strong risk indicator of osteoarthritis of the major weight-bearing joints (III). This effect has been seen in several studies (Hartz et al. 1986; Davis et al. 1988; Felson et al. 1988; Davis et al. 1989; Davis et al. 1990a; Felson 1990a; Vingård 1991), and no evidence seems to counter it. Obesity is also a specific risk indicator for osteoarthritis, it was not associated with the chronic spinal disorders (I; II). The most plausible interpretation is that the effect is largely the due to an increased physical burden on the hip and knee joints. Cartilage damage could occur either because of decreased opportunities for regeneration or increased rates of minor or major impact injury. Other mechanisms may exist, as many other joints besides the knees and hips exhibit an increased prevalence of osteoarthritis in obese persons (van Saase et al. 1988). Whatever the mechanism, the case is strong enough to encourage weight control in the population, as if such a suggestion needed additional support.

The accumulated evidence to blame these risk indicators for the common musculoskeletal syndromes of low back pain, chronic neck pain and osteoarthritis of the knees and hips is evaluated in Table 3. The criteria for the evaluation are adapted from those suggested by Sir Austin Bradford Hill (Hill 1965). Certain criteria have not been included. Specificity of the association is obviously not true for any of these conditions; the very universality of the risk indicators is of interest. There should be no question about plausibility and coherence with what is otherwise known about the syndromes. A definite mechanism is readily imaginable within our present knowledge for all these associations. The evidence from intervention studies was considered
### Table 3. Evaluation of the evidence for a causal role of some risk indicators of common musculoskeletal syndromes.

<table>
<thead>
<tr>
<th>Syndrome</th>
<th>Risk indicator</th>
<th>Strength of the association</th>
<th>Consistency across study designs</th>
<th>Response gradient</th>
<th>Proven time order</th>
<th>Evidence by intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low back pain</td>
<td>Traumatic injury</td>
<td>+++</td>
<td>++</td>
<td>-</td>
<td>++</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Physical work stress</td>
<td>+++</td>
<td>+</td>
<td>++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Mental work stress</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Obesity</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Chronic neck pain</td>
<td>Traumatic injury</td>
<td>++</td>
<td>++</td>
<td>-</td>
<td>++</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Physical work stress</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>+</td>
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<tr>
<td></td>
<td>Mental work stress</td>
<td>++</td>
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<tr>
<td></td>
<td>Obesity</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Osteoarthritis of large joints</td>
<td>Traumatic Injury</td>
<td>+++</td>
<td>++</td>
<td>+</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Physical work stress</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Obesity</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

+++  Strong evidence  
++   Good evidence  
+    Some evidence  
-    No evidence or not studied
by Hill a special and rare but powerful kind; since Cochrane's strong promotion of randomised controlled trials (Cochrane 1972) it is not quite as rare as earlier.

**Smoking.** Heavy smoking was found to be a specific risk indicator of non-sciatic low back pain, but not osteoarthritis or 'fibromyalgia', and the association with sciatica and chronic neck pain was accounted for by adjustment for potential confounders (I–IV). This corroborates and extends previous reports (Svensson et al. 1983; Biering-Sørensen and Thomsen 1986; Biering-Sørensen et al. 1989; Deyo and Bass 1989), although Kelsey et al. have reported that smoking increases the risk of herniated disc, both in the cervical and lumbar region (Kelsey et al. 1984a; Kelsey et al. 1984b). However, the slight inconsistency of our findings (no association among young women) (I) and the discrepancy between this study and others on the issue of smoking and sciatica cast a shadow of doubt on the causal effect of smoking on low back pain.

**Parity.** The number of childbirths was a risk indicator of chronic neck pain among the women under 65 in our study (II). Statistical significance aside, the excess risk was not strikingly high. There are no previous reports on this association, and no good biological or social explanations are readily available. It definitely requires replication in independent populations, as it is quite possible this is a chance finding.

**D. Comorbidity**

A stronger association than with any of the variables considered possible causes of the musculoskeletal pain syndromes was found between the syndromes themselves (I; II; IV; V). This tendency to comorbidity extended, in the case of chronic neck pain, non–sciatic low back pain and 'fibro–myalgia', even outside the musculoskeletal system into mental disorders (II; IV). The excess comorbidity with cardiovascular and respiratory disorders was accounted for by common risk indicators.
A tendency to comorbidity has been reported previously (Svensson et al. 1983; Biering-Sørensen and Thomsen 1986; Guralnik et al. 1989; Pincus et al. 1989; Stewart et al. 1989). Coexistence of lumbar and cervical disc degeneration has been reported previously (Hult 1954b; Jacobs et al. 1990). The strength of the associations between common musculoskeletal syndromes observed in this study is a new finding. Known common risk indicators provide a partial explanation, but much is still unexplained.

The comorbidity of various musculoskeletal disorders with mental disorders has been reported several times previously, especially with depressive disorders (Goldenberg 1986; Schmidt and Arntz 1987; Atkinson et al. 1988; Murphy et al. 1988; Summers et al. 1988). It seems that it is not just a case of distress caused by pain, as mental distress also predicts pain syndromes in previously trouble-free subjects (Goldenberg 1986; Leino 1989).

Diabetes was found to be associated with a reduction in the risk of low back pain. This was unexpected, as diabetics have an increased risk of several skeletal changes, including osteoarthritis and hyperostotic spondylosis (Silberberg 1986). No good explanation is readily available.

E. Concepts of chronic musculoskeletal pain syndromes

The categories of chronic musculoskeletal disorders used in this study – low back pain, sciatica, neck pain, symptomatic unilateral and bilateral osteoarthritis of the hip and knee joints – were obviously usable in a general health examination survey setting and provided sufficient discrimination without unwarranted assumptions about etiologically distinct entities. Fibromyalgia was more problematic, and the very concept could be regarded as inappropriate (IV).

The similarity between the risk indicator profiles of osteoarthritis of the weight bearing joints and chronic low back and neck pain syndromes was striking. However, adjusting for these similar risk indicators did not explain the comorbidity between musculoskeletal syndromes. In fact, the syndromes
themselves were even stronger determinants of each other than any of the would-be causative factors. Other explanations are needed besides common causes.

One suggestion is that the goal of ever more specific diagnostic categories is not fully justified; it may be that a general concept of (as yet unexplained) musculoskeletal pain should be used to characterise these patients (Rekola 1993). Such a concept need not encompass all cases or all manifestations of the specific syndromes — after all, they do have specific risk indicators — nor would it necessarily manifest itself in each case with all the syndromes simultaneously.

General musculoskeletal pain is not a syndrome concept. Rather, it is a dimension of varying susceptibility: the same disorder or event could manifest as chronic pain to different degrees in different persons. This chronic pain, more than the underlying disorder or event, triggers processes at the level of the central nervous system (LaRocca 1992; Pertovaara 1992), mental distress (Troup and Slade 1985; Estlander 1992) and illness behaviour (Main et al. 1992) including demand for health services. These processes, as well as the degree of pain, probably vary from one individual to another. They can themselves also feed back to the biological level, with either perpetrating or healing effects.

A concept of general musculoskeletal pain would be helpful in clarifying the problem of fibromyalgia. During the eighties, fibromyalgia was considered an enigmatic syndrome consisting of a characteristic collection of pain, tenderness and general symptoms, the most distinctive being unrefreshing sleep (Yunus et al. 1981; Smythe 1985; McCain and Scudds 1988; Yunus et al. 1989). Later, the general symptoms were deleted from the classification criteria (Wolfe et al. 1990; Consensus conference 1992), and the tender points encountered in these patients are perhaps not as specific as originally suggested (Tunks et al. 1988; Smythe et al. 1992). What is left is a phenomenon of generalised unexplained musculoskeletal pain and heightened pressure sensitivity. This is closer to a (potentially) measurable dimensional attribute with a continuous distribution than to a syndrome. Even the pressure
sensitivity could easily be a response to the widespread pain. It has been argued that a diagnosis attached to a dimensional measurement is relevant only when it results in specific treatment (as in depression) or specific prognosis (as in hypertension) (Jensen 1983; Klerman 1989); otherwise, the measurement itself is more informative (Mirowsky and Ross 1989).

The concept of a dimension of generalised musculoskeletal pain is superior to an unwarranted assumption of a diagnostic entity such as fibromyalgia in several ways. It does not as such imply a need for specialist services. It does not arbitrarily exclude persons who "almost" fulfil the criteria for the syndrome. It does not produce meaningless questions about arbitrary differences in "prevalence". It may aid in understanding the comorbidity of musculoskeletal syndromes, and in this way may even lead to new insights into the nosology of musculoskeletal disorders.

The next stage would be to identify indicators for this dimension of musculoskeletal pain. Mere measurement of pain is not sufficient, the underlying trigger process should be standardised. This is at present not possible. Mental distress is an obvious candidate for a risk indicator, but the search for a "pain personality" has been unrewarding (Schmidt and Arntz 1987; Marbach et al. 1988; Frymoyer 1992) and depression seems to follow, rather than precede, chronic low back pain (Atkinson et al. 1991; Polatin et al. 1993). The next candidates are anxiety and substance abuse (Atkinson et al. 1991; Polatin et al. 1993).

For epidemiological studies, this creates a model of at least two stages in the pathogenesis of chronic musculoskeletal syndromes. First, an initiating event or disorder with risk indicators of its own must occur. This would lead to a syndrome production process with its own risk indicators and modifiers, one of which is the susceptibility to generalised musculoskeletal pain.
F. Disability in chronic musculoskeletal syndromes

The fact that musculoskeletal disorders are causes of disability is not in question (Wood and Badley 1978; WHO 1980; Cunningham and Kelsey 1984). What this study has provided is an analysis of the relative effects of different chronic musculoskeletal disorders on different measures of disability in different strata of the population, and an estimate of the total community impact, in terms of disability, produced by musculoskeletal disorders.

The present study showed that even in the general population, not just patient groups from referral centres, chronic inflammatory arthritis was by far the strongest musculoskeletal determinant of disability (V). The odds ratio of disability associated with inflammatory arthritis was only enhanced by adjusting for other disorders. This is probably due to inflammatory arthritis having a low rate of comorbidity (I; II): the more comprehensive models remove persons with other causes of disability from the referent category.

Hip joint osteoarthritis was a potent determinant of disability among the elderly and knee osteoarthritis was so common that its somewhat lower risk resulted in a high population attributable fraction. These are not unexpected findings. They do, however, clearly emphasise the social importance of these disorders. The status of chronic back pain as the great disabler of working age people was clearly demonstrated.

The various medical conditions were diagnosed and included in the logistic regression models independently of each other. If the model is valid and there is nothing qualitatively different in the state of multiple illnesses, one can estimate the combined effect of several comorbid conditions by multiplying the odds ratios. By this approach, a 60-year-old person with osteoarthritis affecting both the knee and the hip joints and with a chronic low back pain syndrome (not at all uncommon a combination) would have an 18-fold increased odds of occasional or regular need for help, compared to one without these disorders (V).
The attributable fraction of occasional need for help associated with musculoskeletal disorders among the elderly was smaller than for other disability categories. This suggests that among the elderly, such need for help is not so much an illness–related phenomenon as part of all aging. More severe disability remains largely attributable to morbidity (V).

Although education, physical stress at work and a deviant body weight carried independent significance in modelling disability, they did not materially modify the associations between diseases and disability. Of these three, education was the strongest. This may still reflect a concealed effect of illness: the severity of illness may vary within the disorder categories used in this study, and this variation may be associated with the level of education (Callahan and Pincus 1988). Another possibility is that a similar illness may really restrict the activities of a less educated person worse than of one with better intellectual resources. An analogous explanation could apply for physically heavy work and severe obesity.
VII. Summary

This report is based on the Mini–Finland Health Survey, a comprehensive health examination survey representative of the population of Finland aged 30 years or more. In the survey, musculoskeletal disorders were addressed as a major public health problem, and analyses of the survey data have resulted in numerous important findings.

Chronic low back pain has received extensive attention in epidemiological studies, especially in the United Kingdom, Sweden, Canada and Finland. There is still scope for identification of risk indicators, and this was the focus of the first study (I).

Chronic neck pain as a clinically defined condition has been little studied, and was the focus of the second study (II). This study was the first to provide a comprehensive account of the prevalence and risk indicators of chronic neck pain in the general population, and to estimate its effect on disability.

Osteoarthritis has attracted more epidemiological attention than the low back pain or neck pain. Two features distinguish the third study (III) from most previous ones. First, the definition used in the present study was primarily dependent on symptoms and clinical findings, whereas in most previous studies the focus has been on radiographic osteoarthritis. Second, much more is known about osteoarthritis of the knee joints than that of the hips.

In the fourth study (IV), an attempt was made to devise an operational definition of primary fibromyalgia and study the prevalence and risk indicators of this elusive disorder. Prior to this, no population studies of fibromyalgia had been reported.
The fifth study (V) builds on the foundation of the earlier studies and extends the question to the consequences of musculoskeletal disorders – disability and handicap. In it, a comprehensive view of the causation of disability was adopted and all major chronic disorders, not only musculoskeletal ones, were simultaneously modelled as determinants of disability. In addition to these, several non-medical modifiers of the disease–disability relation were considered.

A. Prevalence of chronic musculoskeletal pain

The musculoskeletal pain syndromes were identified by a procedure of screening interviews, questionnaires and basic tests and measurements, with a standardised clinical examination for those with possible disorders; the original sample was 8,000 persons, 7,217 (90%) participated in the screening phase and 3,434 persons (90% of those invited) in the diagnostic phase.

The prevalence of the syndromes was close to or lower than that expected from health interviews or questionnaire surveys. Non–sciatic low back pain was present in 11.6% and sciatica in 5.1% of those aged 30–64. Chronic neck pain was diagnosed in 9.5% of men and 13.5% of women of all ages more than 30 years. Osteoarthritis of the hips was identified in 4.1% of the men and in 6.0% of the women. The operational definition of 'fibromyalgia' was applicable to 0.75% of the whole population, with a female preponderance.

B. Risk indicators

When analysed by logistic regression models adjusting for sex, age and other identified risk indicators, physical stress at work, a history of injury to the specific body region and the presence of other coexistent musculoskeletal disorders, were risk indicators that all the studied musculoskeletal problems had in common. Of these, comorbidity was the strongest, but it is not usually considered a potentially causal determinant.
The consistent, strong, dose-dependent association of physically heavy work with chronic neck pain, low back pain, sciatica and osteoarthritis can be interpreted as potentially causal. The same conclusion applies to a history of trauma; a previous injury to the neck, arm or back is associated with chronic neck pain, a previous injury to the back is associated with sciatica and other low back pain, and a previous injury to the lower extremity is associated with osteoarthritis of the hip, especially a unilateral one. However, a slight doubt remains, as these risk indicators were identified in a retrospective context, and some degree of recall bias is likely.

Risk indicators seen in only some syndromes were body height, obesity, mental stress at work, smoking, parity and coexistent non-musculoskeletal disorders.

Body height was associated with sciatica but not other low back pain, and in a stratified analysis even this association was only significant among middle-aged men. The evidence for this risk indicator being a causal determinant is far from conclusive.

Overweight persons were at a strongly increased risk of having osteoarthritis of the hips, especially bilaterally. This association seems likely to be due to a true effect of excess weight actually causing degenerative joint disease, as it has been seen in several other studies, some of them prospective, and applies equally to degeneration in the knee joints.

A heavy body was also associated with chronic neck pain, but the association was not linear – the highest risk was associated with moderate over-weight. This irregularity suggests that obesity is here an indicator of some more basic risk factor and is not causative itself.

Mental stress at work, either present or previous, was associated with chronic neck pain, low back pain and sciatica. In the case of neck pain, the risk carried by mental stress was as high as that carried by physical stress; this was not the case with low back pain. These associations have been reported in a variety of study designs including some prospective ones, they
are relatively strong and the risk is dose-dependent. This would suggest at least some form of causation, but the issue is hardly settled yet.

An excess risk of low back pain was found among heavy smokers, even after multivariate adjustment. However, the association was not seen for other musculoskeletal disorders, and even in the case of non–sciatic low back pain was inconsistent over sex and age groups. This finding does not offer definitive support for the hypothesis that smoking as such injures the back, although it certainly is not refuted either.

A surprising finding was that women with a large number of childbirths had an increased risk of chronic neck pain. The risk was significant but not strikingly high, and did not extend to those aged 65 or more. As no explanation is readily available, it is quite possible that this is a chance finding.

Two important findings concerned comorbidity with non-musculoskeletal disorders. First, mental disorders were diagnosed more often than expected among those with chronic neck pain, low back pain (but not sciatica) and ‘fibromyalgia’. Second, people with diabetes had a smaller risk of low back pain than expected.

C. Concepts of musculoskeletal disorders

The different syndromes of chronic musculoskeletal pain had a certain degree of specificity in their risk indicator profiles. The distinctions used in this study — separating chronic neck pain from low back pain and osteoarthritis, sciatica from non–sciatic low back pain and unilateral from bilateral osteoarthritis, and ‘fibromyalgia’ from all of these — seem justified. However, a large degree of overlap in the strongest risk indicators, in addition to a high comorbidity not explained by these shared determinants, suggests that part of the phenomenon of chronic musculoskeletal disorders could be construed as a concept of generalised musculoskeletal pain.
D. Disability

Inflammatory arthritis was a powerful determinant of reduced working capacity and both occasional and regular need for help. Osteoarthritis of the knee and especially of the hip was also a strong determinant of both occasional and regular need for help, and low back pain was a strong determinant of both work disability and need for help among the working age population. The effects other musculoskeletal disorders had on disability were reduced by adjusting for comorbidity.

The proportion of all forms of disability that could be attributed to musculoskeletal disorders was close to 20%, in models adjusting for age, sex, other disabling illness and significant non-medical risk indicators (limited education, excess obesity or thinness and physically strenuous work). The disorders with the highest community impact were chronic low back pain among those aged 30–64 and osteoarthritis of the hips and knees. Even though it is relatively rare, chronic inflammatory arthritis is so severe an illness that it, too, had a large community impact.
VIII. Yhteenvertto


Tässä julkaisussa tarkastellaan viittä osatutkimusta, jotka perustuvat Kansaneläkelaitoksen Mini-Suomi-terveystutkimukseen. Mini-Suomi-tutkimus on laaja-alainen väestötutkimus, jossa Suomen 30 vuotta täyttäneet väestöä edustavassa 8 000 hengen näytteessä selvitettiin monipuolisesti osanot-tajien terveydentilaa ja toimintakykyä. Tuki- ja liikuntaelinten sairauksilla oli tutkimuksessa keskeinen osa.

Ensimmäisessä osatutkimuksessa (I) selvitettiin kronisen selkäoireyhtymän ja iskiaksen vaaratekijöitä. Toinen osatutkimus (II) koski niskaoireyhtymää, ja se on ensimmäinen väestötutkimus klinisesti määriteltyä niskaoireyhtymän vaaratekijöistä. Kolmanneessa osatutkimuksessa (III) tarkasteltiin lonkan nivelriikkoa sekä raskasta ruumiillista työtä, tapaturmia ja liikapainoa sen vaaratekijöinä. Neljännessä osatyössä (IV) pyrittiin rakentamaan operatio-naalin määritelmän fibromyalgialle ja tutkimaan sen esiintyvyyttä väestössä; kyseessä on ensimmäinen väestötutkimus tästä aiheesta.

A. Tuki- ja liikuntaelimistön oireyhtymien esiintyvyys

Tuki- ja liikuntaelimistön sairaudet tunnistettiin vakiomuotoisessa lääkärintutkimuksessa, johon osanottajat kutsuttiin seulonnan perusteella. Seulonta perustui kyselyihin, haastatteluihin ja niveltoimintatutkimukseen. Alkuperäisestä otoksesta 7 217 henkeä (90 %) osallistui seulontavaiheeseen ja 3 434 (90 % kutsutuista) tuki- ja liikuntailinsairauksia koskevaan lääkärintutkimukseen.

Eri sairauksien ja oireyhtymien esiintyvyys oli lähes sama tai hieman pienempi kuin seulontavaiheeseen sisältyneen haastattelu- ja kyselytutkimusten perusteella olivat odotettu. Selkäoireyhtymä ilman iskiä esiintyi 11,6 %:lla 30–64-vuotiaista, iskiisainsaireyhtymä 5,1 %:lla. Koko 30 vuotta täyttäneessä väestössä niskaoireyhtymän esiintyvyys oli 9,5 % miesten keskuudessa ja 13,5 % naissilla. Lonkan nivelrikon esiintyvyys miehillä oli 4,1 % ja naissilla 6,0 %. ’Fibromyalgian’ tutkimuskriteerit täytti 0,75 % kaikista tutkituista, ja näistä kaksi kolmannesta oli naisia.

B. Vaaratekijät

Vaaratekijöihin liittyyvä tuki- ja liikuntaelinoireyhtymien riskiä arviotiin vakioiden vertailu sukuvalon, iän ja muiden vaaratekijöiden suhteen logistiisilla regressiomalleilla. Kaikkien tutkittujen suurten oireyhtymien vaaratekijöiksi osoittautuivat työn (nykyisen tai aikaisemman) fyysinen kuormittavuus, kyseiseen kehonsaan sattunut tapaturma sekä muiden tuki- ja liikuntaelimistösairauksien samanaikainen olemassaolo. Viimeksi mainittu oli suhteelliselta riskiltään suurin, mutta sitä ei voine pitää syytekiä, vaan yhteydelle on ilmeisesti muita selityksiä.

Työn fyysisen kuormittavuuden yhteys niskaoireyhtymään, iskiakseen, selkäoireyhtymään ja nivelrikoon oli voimakas, ja se on altistuksen asteesta riippuvainen ja yhtäläinen eri ikäryhmissä. Yhteyden voimakkuus ei myöskään muuttunut, kun muiden samanaikaisten vaaratekijöiden vaikutus vakiotiin. Työn kuormittavuutta on aihetta pitää näiden sairauksien mahdollisena...
syytekijänä, ei ainoastaan vaaran mittarina. Myös aikaisemmin koettu tapaturma oli siinä määrin voimakas ja johdonmukainen vaatekeijä, että sitä voinee pitää tutkittujen kroonisten tuki- ja liikuntaelinsairauksien syynä. Tässä suhteessa jää vähäinen epäily, sillä tieto tapaturmasta on kysyttä ihmisiltä, jotka jo tietävät omit vaivansa, joten harhan mahdollisuus on olemassa.

Pituus oli yhteydessä iskiaisoireyhtymään mutta ei muuhun selkäkipuun, ja ositettuina aineistossa tämäkin yhteys on tilastollisesti merkitsevä ainoastaan 50–64-vuotiailla miehille. Tämän vaaretkijän syvällisyydestä iskiaksen syntyn ei ole likimainkaan riittävä todisteita.

Lihavilla ihmisillä oli laajoja huomattavasti enemmän lonkan nivelrikkoa, erityisesti molemminpuolin nivelrikko oli heillä yleinen. Tässä yhteydessä syy–seurausuhde vaikuttaa todennäköiseltä, sillä sama yhteys on havaittu useissa eri tutkimusasetelmissa, ja lihavuuden yhteys polvenkin nivelrikkoon on vakuuttavasti todettu.

Lihavuus oli myös yhteydessä niskaoireyhtymään, mutta yhteys ei ollut suoraviivainen, vaan vaarasahtude olisuriin kohtuullisesti liikapainoisilla. Tämä epäasännöllisyys viittaa siihen, että lihavuus ei itse olisi niskaoireyhtymän syy, vaan ainoastaan osoittaa jonkin toisen, perustavamman, vaaretkijän vaikutusta.

Työn henkinen kuormittavuus oli yhteydessä selkäoireyhtymään, niin iskiakseen kuin muuhunkin selkäkipuun, sekä niskaoireyhtymään. Niskaoireyhtymän suhteen yhteys oli yhtä vahva kuin työn fyysisellä kuormittavuudella, mutta selkäoireyhtymän suhteen yhteys oli hieman helkompia. Yhteys on suhteellisen voimakas ja riippuvainen altistuksen asteesta. Sama yhteys on todettu useissa muissa tutkimuksissa, joista erää ovat seurantatutkimuksia. Tämä viittaisi jonkinluonteiseen syy–yhteyteen, mutta kysymys on vielä toistaiseksi jätettävä aivoimksi.

Runsaasti tupakoivat käräjät muita selvästi yleisemmin selkäoireyhtymän vaivoista. Samaa yhteyttä ei todettu suhteessa muihin tuki- ja liikuntaelimis-
tön sairauksiin; selkäoireyhtymän vaivoissakin yhteys puuttui nuorempien naisten osajoukossa. Nämä havainnot eivät tarjoa lopullista tukea hypoteesille, jonka mukaan tupakointi vaarantaa selän terveyttä, mutta ne eivät myös käännä millään muotoa kumoaa sitä.

Yllättävä löydös oli monisynnyttäjien lisääntyminen vaara sairastaa niskaoireyhymää. Tilastollisesta merkitsevyydestään huolimatta yhteys ei ollut erityisen voimakas, eikä sitä voitu todeta eläkeikäisillä. On vallan mahdollista, että kyseessä on sattumalöydös.

Tuki- ja liikuntaelimistön ja muiden sairauksien kasautumisesta todettiin kaksi tärkeää selkkaa. Ensinnäkin mielelentoreyden häiriöitä esiintyi odotettua enemmän niskaoireyhtymää, tavallista selkäoireyhtymää sekä 'fibromyal giaa' sairastavilla. Toiseksi diabeetikoilla oli odotettua vähemmän selkäoireyhtymän vaivoja.

**C. Tuki- ja liikuntaelimistön oireyhtymien käsitteistä**

D. Toiminnanvajavuus


Tuki- ja liikuntaelinten sairaudet lisääivät tämän tutkimuksen mukaan väestön toiminnanvajavuutta likimain 20%. Tällöin oli vakioitu ikä, sukupuoli, muut haittaa aiheuttavat sairaudet sekä terveydentilan ulkopuoliset toiminnanvaja-vuuden vaaratekijät (niukka koulutus, runsas yli- tai alipaino sekä työn fyysinen kuormittavuus). Työikäisessä väestössä suurimmat väestöyosuu-deet todettiin selkäoireyhtymällä sekä lonkan ja polven nivelrikolla, eläkeikäisillä selkäoireyhtymän merkitys oli vähäisempi. Myös moniniveltulehdus, suhteellisesta harvinaisuudestaan huolimatta, aiheuttaa merkittävän osan väestön toiminnanvajavuudesta.
References


Bongers PM, Boshuizen HC, Hulshof CTJ, Koemeester AP. Back disorders in crane operators exposed to whole–body vibration. Int Arch Occup Environ Health 1988a; 60: 129–137.


