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Musculoskeletal Disorders among Farmers and Referents, with Special Reference to Occurence, Health Care Utilization and Etiological Factors

A Population-based Study

BY

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Abstract

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Objectives. To study the prevalence of musculoskeletal symptoms among farmers as compared to rural referents and to evaluate the effects of physical work exposures, psychosocial factors, lifestyle and comorbidity.

Material and methods. A cross-sectional population-based survey of 1013 farmers and 769 matched referents was performed. Data on various symptoms, consultations and sick leave and information on primary health care and hospital admissions were obtained along with information on physical workload, psychosocial factors and lifestyle.

Results. The farmers reported higher lifetime prevalence of symptoms from hands and forearms, low back and hips as compared to the referents. However, the farmers did not seek medical advice more often than the referents, and they reported significantly fewer sick leaves. After adjustment for the influence of physical work exposure, farmers still had a excess rate of low back pain (LBP) and hip symptoms as compared with the referents, while a lower rate of neck-shoulder symptoms was revealed. Several of the psychosocial variables were associated with LBP but the difference in LBP prevalence between farmers and referents could only be explained to some extent. LBP was associated with musculoskeletal symptoms other than LBP and with chest discomfort, dyspepsia, symptoms from mucous membranes, skin problems, work-related fever attacks, and primary care for digestive disorders. Presence of both respiratory and digestive disorders doubled the LBP prevalence.

Conclusions. Symptoms from hips and low back were more frequent among farmers than among referents, but farmers did not seek more health care and reported fewer sick leaves than referents. Physical work exposure and psychosocial factors did not explain the differences in low back and hip symptoms between the two groups. Significant associations between LBP and digestive and respiratory disorders might indicate that these disorders may have etiological factors in common.

Keywords: farmers, agriculture, rural, musculoskeletal disorders, sick leave, low back pain, hip problems, physical workload, psychosocial factors, lifestyle, comorbidity, work-related fever attacks, epidemiology, etiology

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Original papers

This thesis is based on the following papers, referred to in the text by their Roman numerals.

I Holmberg S, Stiernström EL, Thelin A, Svärdsudd K. Musculoskeletal symptoms among farmers and non-farmers: A population-based study. Int J Occup Environ Health 2002;8:339-345.

II Holmberg S, Thelin A, Stiernström EL, Svärdsudd K. The impact of physical work exposure on musculoskeletal symptoms among farmers and rural non-farmers. A population-based study. Ann Agric Environ Med 2003;10:179-184.

III Holmberg S, Thelin A, Stiernström EL, Svärdsudd K. Psychosocial factors and low back pain, consultations, and sick leave among farmers and rural referents: A population-based study. J Occup Environ Med 2004;46:993-998.

IV Holmberg S, Thelin A, Stiernström EL, Svärdsudd K. Low back pain comorbidity among male farmers and rural referents: A population-based study. Submitted.

Contents

Foreword

Health is unequally distributed among people. From a global point of view, warfare, poverty and related hardships are probably the most important determinants of deteriorating health. However, large variations in health exist also within privileged westernized civilizations. There are considerable variations in mortality and morbidity according to geographical area, sex, profession, work exposures, employment status, educational level, income, etc.[2].

Medical science has traditionally studied health from a pathogenetic perspective taking its starting point in diseases or patients. Focus has been on studying the occurrence of diseases in various populations, its natural history and risk factors and the aim has been to treat patients and improve quality of life. A considerable part of the total disease burden and mortality is, however, attributed to modifiable risk factors [137,139]. The implementation of this knowledge on the individual and the societal level to promote health has been successful in some respects, for example in reducing the prevalence of smoking and implementing the use of safety belts in cars. However, concerning other modifiable risk factors such as obesity and physical inactivity, implementation has to date been less successful.

If we want to study health and health-promoting factors, a salutogenetic perspective might enhance our understanding. Salutogenesis is the study of health and its causes on the health-disease continuum, as opposed to pathogenesis, which is the study of diseases and its causes. The late Aaron Antonovsky first proposed the concept of salutogenesis. He was an Israeli sociology professor fascinated by holocaust survivors. Antonovsky dealt with the importance of coping strategies in handling life stressors, and his instrument for measuring sense of coherence attracted widespread attention [7].

The inspiration for the project "Health Through Work" ("Frisk av Jobbet" in Swedish), on which this thesis is based, arose from the idea that a study of salutogenetic factors would be most favorable in a population with low morbidity. Swedish and international studies indicate that farmers seem to have lower mortality and morbidity, especially regarding heart disease, mental disorders and certain cancers than other occupational groups [148,160,183,197,217,222]. Farmers were therefore considered a suitable study population, and the main aim of the project was to study salutogenetic factors, e.g. why farmers less often acquire certain diseases, and seek less health care and sickness insurance benefits. Regarding musculoskeletal disorders, farmers are believed to be more afflicted than many other groups [211]. The physically arduous demands of traditional farming are thought to be the main cause, but evidence of causality is restricted. In addition, farmers probably differ from other occupational groups with regard to care-seeking behavior and sick leave when afflicted with musculoskeletal disorders.

The number of farmers is steadily decreasing owing to ongoing changes in the agricultural sector in Sweden. If work-related factors or traditional farming lifestyles promote health and keep the morbidity low it should be very interesting to undertake research to understand the mechanisms of salutogenesis among farmers. Structural changes in rural areas related to new techniques and demography affect social structures and will probably modify future morbidity patterns [198].

Introduction

Musculoskeletal disorders

Definitions

Musculoskeletal disorders are disorders or diseases of the muscles, tendons, ligaments, peripheral nerves, joints, cartilage, bones and/or supporting vessels. The term *work-related musculoskeletal disorders* is often used in occupational medicine, implying work factors as causal or modifying components [60,67]. Acute conditions attributable to accidents or instantaneous events are normally not included in the term. In this thesis, the neutral terms musculoskeletal symptoms and musculoskeletal disorders are used since the magnitude of causal contributions of work exposures in relation to other causes is largely unknown and sometimes questioned [60,70,95]. Musculoskeletal problems related to accidents, inflammatory disorders, endocrine diseases or other well-defined conditions are not included in the term musculoskeletal disorders as used in this thesis.

Musculoskeletal symptoms are common, and are encountered by most people from time to time, for example due to minor traumas or as stiffness following exercise. These experiences are not in general denoted disease symptom. Since pain, aches, stiffness, numbness, etc. are subjective experiences it is, by definition, impossible to establish objective cut-off points for when the feeling in or from the body should be denoted a symptom. This cut-off point can only be set by the individual him or herself and is therefore influenced by previous personal experience, culture and norms, the actual situation the person is encountering, and so forth [124]. Pain-related fear is sometimes more disabling than the pain itself [41]. For research purposes, standardized questions or rating scales must be used to make comparisons possible. Evaluation of functioning and work capabilities related to the symptoms and whether health care professionals are consulted are often used for classification and grading. The Nordic Questionnaire [104] and adaptations have been widely used.

In this study, we focused on symptoms from the neck and shoulders, hands and forearms, low back, hips and knees. Such symptoms are frequently reported in occupational settings, are relevant to farmers, and are distinguishable in research. Regional symptoms are ergonomically easier to relate to various physical occupational exposures than general pain syndromes. This probably applies both to the person experiencing the symptoms (potential for recall bias) and to health professionals and researchers interpreting the information.

Prevalence

Musculoskeletal symptoms are common in the general population and many epidemiological studies from all over the world have investigated the incidence and the prevalence of various disorders. The possibilities of making good estimations of prevalence are, however, limited despite the large number of studies. This is partly due to variations in definitions and classifications of unspecific symptoms and more specified disorders. It is important to know what comparison groups are used when increased or decreased risks related to various exposures are discussed.

Investigations from recent decades show variations in lifetime prevalence of low back pain from 10 to 85 percent in various populations [210]. Studies on apparently similar westernized populations also show large differences in prevalence. This illustrates the difficulties with definitions and classifications discussed above. However, several international reports estimate the lifetime prevalence rate of low back pain to be around 60-80 percent and the point prevalence to be 15-30 percent [33,95,110,111,153,210]. Many studies indicate an increase in prevalence of back pain up to middle age with a slight decline in older age groups, at least concerning more severe chronic cases [28]. Episodic or intermittently occurring pain is common. A small percentage have continuous chronic symptoms. In clinical practice low back pain is often classified as acute, sub-acute or chronic [45,95]. Low back pain is denoted as specific or unspecific depending on whether or not a pathoanatomical diagnosis can be established. The majority of cases are labeled unspecific low back pain. Spinal degenerative disc disease with or without sciatica indicating nerve root engagement can sometimes be verified. Other radiological findings such as spondylolysis, spondylolisthesis and spinal stenosis are sometimes demonstrated, but the significance of these observations for the presented symptoms is often difficult to ascertain. Modern studies using magnetic resonance imaging have shown that disc degeneration is prevalent in the general working population but with surprisingly low correlation to back symptoms [20,171].

Low back problems tend to increase over time in Sweden according to national household surveys [172]. In 1985, current back pain was reported by 6.5 percent of the entire population, aged 16-84. Ten years later, back pain was reported by 8.0 percent of the population. Epidemiological research, however, does not verify any historical or epidemiological evidence for an increasing prevalence of low back pain [6,95,111]. Observed differences in prevalence seem to be related more to how questions on low back pain are posed than to actual variations in prevalence in comparable studies over time

[95]. Official data on diagnoses, health care utilization and sick leave mostly show lower frequencies of low back pain than data derived from different population based surveys.

Neck pain seems to be less prevalent than low back pain, although there are fewer epidemiological studies available. As for low back pain, definitions and classifications of what is meant by neck pain differ between studies. In many studies, shoulder pain is not distinguished from neck pain and in clinical practice neck and shoulder problems often occur simultaneously. Pathoanatomical explanations for the symptoms cannot be found for the majority of cases. The lifetime prevalence of neck pain was 66 percent of the adult population in a Canadian study [38]. High prevalence has been shown in Nordic studies as well [24,25,143,177]. Studies indicate that neck pain is generally more prevalent among women than among men and that the prevalence increases with age [25,72,177]. Shoulder symptoms depending on specific disease processes in or in relation to the shoulder joint can sometimes be distinguished from neck problems. Osteoarthritis of the shoulder joints (acromio-clavicular joint and gleno-humoral joint), impingement syndromes and frozen shoulder are examples of such entities [70]. However, neck and shoulder symptoms are often related to increased muscle tension and are then less distinct and often incorporated into broader terms such as tension neck syndrome or neck-shoulder myalgia [68,70].

Symptoms from hands and forearms are also quite common. Carpal tunnel syndrome emanating from the wrist and epicondylitis in the elbow are often encountered in clinical practice and are sometimes related to occupational activity [70]. Predominant symptoms for carpal tunnel syndrome are numbness, paresthesia and, later, muscular weakness in the hands. Nocturnal symptoms are frequent. The symptoms are due to entrapment of the median nerve as it passes through the carpal tunnel [48]. Carpal tunnel syndrome is somewhat more common among women than among men. Pregnancy, endocrine diseases and obesity are predisposing conditions [48] and occupational physical exposures are identified as potential risk factors [66]. In a recent review of the epidemiological literature, the occurrence of soft-tissue rheumatic disorders of the upper limb was estimated. Symptoms from wrist or hand are reported by 9 to 17 percent of different populations (point estimate), and pain in the elbow by approximately 10 percent [212]. As many as 6 percent of adults may have carpal tunnel syndrome [212]. Other occupationally related conditions, such as flexor pronator syndrome [213] and tenosynovitis [215] may also cause symptoms from hands and forearms. However, these causes are presumably less prevalent.

Long-lasting musculoskeletal symptoms from a lower limb is often due to osteoarthritis of the hip or knee joint. Osteoarthritis is a degenerative disease starting in the cartilage, and later affecting the surrounding joint structures. What actually causes the pain in osteoarthritis is unknown [56]. To confirm osteoarthritis, radiological findings should be present. Primary osteoarthritis, not secondary to injury or other disease, is an unusual diagnosis before the age of 45. The prevalence of osteoarthritis increases exponentially with age [57,103]. Hip osteoarthritis occurs in approximately 3 percent of adults above 30 years of age [42,56,70]. The prevalence of knee osteoarthritis is probably somewhat higher and has been estimated at approximately 6 percent in the United States [56]. The occurrence of knee osteoarthritis is also considerable in Sweden [182]. Pain or other problems from a lower limb may be attributable to milder forms of osteoarthritis not yet radiologically confirmed or to other causes. Trochanteritis with lateral hip pain is common in clinical practice. Acute or chronic symptoms due to knee injuries affecting ligaments or menisci are common in the general population, and are more frequent among males than among females [176]. In addition, these injuries predispose to subsequent development of osteoarthritis [35,36,123]. The prevalence of musculoskeletal symptoms from a lower extremity has been estimated in a few studies. In a random sample of 65-74 year-olds in Great Britain, 19 percent reported hip pain and 32 percent reported knee pain during the past 12 months [43]. A Finnish study based on more than 2000 workers, initially free from symptoms, reported a one-year incidence of knee pain of approximately 10 percent [138].

Consequences and costs

Musculoskeletal pain is one of the most common reasons for medical consultations in primary health care [90,163]. Approximately 25 percent of individuals with neck or back pain seek a health care provider [30,39]. A high level of experienced disability and high pain intensity were the most decisive factors for seeking care in a recent study on low back pain [140]. Pain does not necessarily lead to deteriorating functional capacity. It is common that individuals experience some activities as aggravating pain, and therefore adjust their activities. Functional impairment might follow either from primary pain or secondarily from decreased activity. Physical activity sometimes reduces the experience of pain and rehabilitates lost functions [165]. Strong evidence supports the advice to patients with acute low back pain to remain physically active instead of resting in bed [209].

Work capacity when suffering from musculoskeletal disorders varies considerably, owing to individual factors and situational circumstances. Musculoskeletal disorders have been the most common reason for sick leave in Sweden and other industrialized countries, in recent years surpassed by psychological disorders. Many other factors such as psychosocial conditions [122], comorbidity [174] and other non-medical circumstances [50] in addition to current musculoskeletal symptoms influence sick leave rates. Disease in the musculoskeletal system was the most common reason for disability pension in a Swedish cohort of middle-aged men [142].

The total direct costs, including all primary and secondary care, for back pain in Sweden in 1995 was estimated to SEK 2.4 billion [95]. Hospital care is needed by 1-2 percent of all patients with back problems, and physicians, physiotherapists, chiropractors, and others treat the vast majority of those seeking health care in primary care. Indirect costs, including sick leave and disability pensions and societal costs were estimated in the same study to be SEK 27.0 billion [95]. Differences in the organization of health care and social insurance systems make comparisons with other countries difficult. It has been estimated that the societal cost of osteoarthritis in Sweden is around SEK 10 billion, and the cost is assumed to be increasing, mainly due to the demographic situation, with increasing number of aged persons [182].

Etiology

A large number of factors have been studied and evaluated for their association with musculoskeletal disorders. Much interest has been devoted to investigating the effects of physical workload, psychosocial factors, and various individual characteristics. However, our knowledge on causality regarding these factors and musculoskeletal symptoms and disorders is limited, in spite of the large number of studies.

Physical factors

Many studies report associations between low back pain and whole body vibrations [18,23,102], difficult working positions such as frequent bending and twisting [136,161,164] and heavy lifting [149,179,191]. Recent reviews conclude that the associations between physical load factors and low back pain are quite consistent among studies [15,28,83,95]. Monotonous and repetitive work and work with the hands above shoulder level have been associated with neck and shoulder pain [8,49,81,95,150]. There is limited evidence for associations between awkward working positions and workplace design with neck problems, but there is insufficient evidence today for evaluation of other physical risk factors in relation to neck problems [70].

Osteoarthritis of the hip and knee has been associated with physical workload in several studies [34,55,131,220]. Felson et al. estimated that occupationally related factors cause anywhere from 15% to 30% of knee osteoarthritis in men [55]. Occupational physical exposures have been associated with disorders in the hand and forearm [66,156,167,190,214,216]. Long-term exposure to hand-arm vibrations seem to be an occupationally related risk factor for hand symptoms, due to vasospastic reactions and neuropathy [187].

Psychosocial factors

Occupational psychosocial factors, such as job satisfaction, work relations, work demands and work control show associations with low back pain and with neck-shoulder pain in several studies [3,16,17,85,93,94,120,177,204]. Other studies have not shown significant associations with psychosocial factors [59,107]. Family related psychosocial factors can have both positive and negative effects in relation to musculoskeletal symptoms and how symptoms are dealt with [11,26,58,141]. A systematic review of psychosocial factors at work and private life found strong evidence for low social support in the workplace and low job satisfaction as risk factors for back pain [84]. In addition, psychological factors play a significant role in chronic neck and back pain and perhaps especially for the transition into chronic phases [121]. Associations between adverse psychosocial work factors and high physical workload have been demonstrated, and interactive effects are probable [44,96,204].

Individual factors

Individual and lifestyle factors such as age, sex, weight, height, musculoskeletal strength, physical capacity, comorbidity and smoking have been studied in relation to back pain and, to a lesser extent, in relation to other musculoskeletal symptoms. There are no individual factors that are incontrovertibly related to neck or back pain [95]. The strongest predictor of future neck or back pain is having had a previous pain episode from the back [13,95]. Some studies show that overweight is a weak predictor of low back pain and that height is positively associated with disc degeneration among men [46,62,65,73,86]. No association between weight and low back pain has been observed in other studies [28,149,175].

Obesity is a risk factor for knee osteoarthritis [53,56,80,133]. An association between obesity and hip osteoarthritis is probable but research results are less conclusive [35,118,188]. A few studies indicate that overweight is also associated with osteoarthritis in non-weight bearing joints, for example in the hand [31,151]. The nature of the relationship between body weight and osteoarthritis is not fully understood [54]. Obesity is a well-known risk factor for carpal tunnel syndrome.

Muscular strength and physical aerobic capacity have been associated with low back pain in some studies but not in others [13,29,115]. Low physical capacity but not muscular strength was found in a Finnish study to predict future back pain among previously pain-free adults [105].

Individuals with back pain often have other complaints as well. Many people with frequent back pain also report pain from other parts of the body [37,65,193]. Weak associations between low back pain and cardiovascular disease, respiratory disorders, depression and general health were found in several studies of low back pain and comorbidity [13,65,74,77,88,192,221]. In one study a fourfold increase in non-back related sick leave among patients with acute low back pain was observed [174].

Smoking has been extensively studied in relation to musculoskeletal disorders. Associations between smoking and disc degeneration have been documented in some epidemiological studies [14,101] and associations between smoking and low back pain have been found in others [46,74] while other studies found no significant associations [22,109,132]. A negative relationship between smoking and osteoarthritis of hip and knee has been found in several studies [35,52,200]. No good explanation for this finding has been proposed, and a recent study with a prospective design did not confirm these results [218].

Most studies on the etiology of musculoskeletal disorders are cross-sectional. Thus, significant information about causality is not yet available. Reported effects of various physical and psychosocial variables are often relatively weak, indicating that these variables account for only a minor portion of the variance. This supports the idea of a multifactorial perspective on musculoskeletal disorders. To enhance our understanding of how and why symptoms and disorders of the musculoskeletal system are generated different research approaches are needed. Studying comorbidity might be one possible form for this research.

Musculoskeletal disorders among farmers

Agricultural work and farming have generally been considered high-risk occupations for musculoskeletal disorders, mainly owing to a high level of physical work exposures. Despite the extensive mechanization of the agricultural sector during the last 50 years, farming is still a physically demanding job for many farmers [4,159]. A British study showed that several physical work exposures were more frequent in farming than in other manual occupations [211]. There is limited research indicating a high prevalence of musculoskeletal disorders and symptoms among farmers [64,130,158,197, 211]. However, the impact of the potential risk factors described above on musculoskeletal disorders among farmers has not been systematically evaluated with matched control groups.

A relatively large number of studies have demonstrated a relationship between hip osteoarthritis and farming [9,40,125,195,200,211,220]. This increased risk has been associated with tractor driving [206]. In a recently published study, farmers with no animals had no special risk of osteoarthritis whereas those farmers working with animals in barns had a significantly increased risk [202]. Knee osteoarthritis has been studied with regard to farming but the results are less conclusive [79,170,220]. Previous knee injuries to the menisci or ligaments are risk factors for later development of knee osteoarthritis [36,51]. Farmers handling cattle and other animals may be at risk for these types of injuries.

High frequencies of low back pain have been reported for farmers [114,116,126,178,211]. Many years of farming has been associated with more low back pain [132,223]. Tractor driving has been focused on as a major causal factor, due to exposure to whole body vibrations [21,119,206]. Part-time farmers having a non-agricultural job as their main occupation had an increased risk of low back pain, according to a study from Iowa [154].

Very few studies on neck and shoulder symptoms and disorders among farmers have been published [135,169,173]. In a Finnish radiological study, spondylosis of the cervical spine was less prevalent among farmers than among dentists [100]. Hand and forearm symptoms with sensorineural and vasospastic related manifestations have been found in farmers and agricultural workers [152,190]. However, more research is needed before any conclusions regarding prevalence and risk factors for neck and upper limb disorders among farmers can be drawn [211].

Most farmers have high physical workloads. Physical work exposures are thought to be causal factors in the development of musculoskeletal symptoms, although there is as yet no strict scientific evidence behind this presumption. If heavy physical workload in general is a causal contributor to musculoskeletal symptoms, then the relative excess risk of musculoskeletal symptoms among farmers should be partly explainable in terms of physical exposures.

Care-seeking and sick leave among farmers

Little is known about farmers' inclination to seek medical care and their utilization of health insurance systems in comparison with other occupational groups or the general population. In clinical practice, experienced family physicians "know" that many farmers are reluctant to seek health care in contrast to other high consumer groups where "over-utilization" of health care might be at hand. We have shown in a previous study that farmers reported lower lifetime incidence of outpatient health care consumption than referents for psychiatric, neurologic, ear-nose and throat, eye, gastrointestinal and skin diseases [186]. Farmers, however, reported more outpatient visits due to trauma, which agrees well with other studies showing a high level of injuries in agriculture [69,183,194]. It is not known whether a low rate of medical consultations for various symptoms indicates a low disease incidence, or whether it reflects different care-seeking behavior among farmers. A British study concerning suicide among farmers revealed no significant difference between farmers and matched controls for number of contacts with their general practitioner or mental health service three months prior to death [19].

High levels of disability and sick leave owing to musculoskeletal disorders or symptoms are reported among Finnish farmers [71,130,157]. Because of the lack of control groups from other occupations or from the general population, it is difficult to draw conclusions about farmers' use of sickness benefits as compared with other groups. In a Swedish study, farmers were found to be five times more likely to receive a pension award for low back disorder than men in other occupations [219]. Difficulties with continuing as a farmer, owing to the nature of farm work or to factors related to self-employment might promote retirement or change to another occupation when farmers encounter musculoskeletal problems. In a study of "elimination" from farming, Thelin and Höglund [199] showed that Swedish farmers changed occupation or retired less often than workers in other occupations. In addition, the reason for changing work among farmers was mostly low income rather than health problems, indicating that the "healthy worker effect" is not one of the main reasons for low morbidity rates among farmers. A possible health related selection into farming might be at hand. There are no studies available addressing this issue. In a Swedish study on mortality and social class, self-employed persons in other occupations than farming had high total mortality, whereas farmers had a low total mortality [222].

Aims of the study

This thesis presents results from cross-sectional baseline data from an ongoing prospective cohort study on farmers and rural referents. The general aim of this thesis was to study the prevalence of musculoskeletal symptoms and disorders among farmers and referents and to analyze the effects of physical and psychosocial factors on musculoskeletal outcomes. The overall question was whether differences in physical work exposures, psychosocial factors and lifestyle can explain differences in musculoskeletal symptoms, medical consultations and sick leave between farmers and occupationally active referents.

The specific aims of this thesis were:

1. To investigate the prevalence of reported musculoskeletal symptoms among Swedish farmers as compared with rural referents.
2. To investigate the prevalence of self-reported medical consultations and sick leave due to musculoskeletal symptoms among farmers as compared with matched referents.
3. To evaluate the influence of physical work exposures on musculoskeletal symptoms among farmers.
4. To evaluate the influence of psychosocial factors and lifestyle, including self-employment, on low back pain, consultations and sick leave among farmers.
5. To investigate comorbidity associated with low back pain among farmers and matched referents.

Material and methods

Study population

The project was designed as a prospective cohort study with farmers and matched referents, and this thesis is based on cross-sectional baseline data from the first survey [186,201].

From the Swedish National Farm Register, all male farmers born 1930 to 1949 and living in nine selected areas in Sweden were sampled in 1989. Since both owners and users of agricultural property are listed in the register, many of those listed have completely non-agricultural occupations, are passive landowners or have a low level of farming activity. In order to identify persons occupationally active in farming, the farmer's representatives in the local branches of the Swedish Farmers Organization (LRF) were contacted personally by the project director. With the help of these representatives, individuals who were engaged at least 25 hours per week in agricultural work were selected. The local branches of the Swedish Farmers Organization are quite small, with each representative covering approximately 50 to 150 members. The representatives' knowledge of occupationally active farmers in the area ought therefore to be good, and the validity of the occupational affiliation to farming in the study group can be assumed to be high.

The age interval of 40-60 years was chosen for two reasons. The participants should be old enough to be settled in their occupation and to have occupational exposure behind them. Secondly, they should be old enough to generate outcome data in 10 years (power calculations were performed on heart disease outcomes). The choice of counties included were made with consideration to known morbidity gradients in the Swedish population [145] and with regard to coverage of different geographical areas where various types of farming production dominate. The aim was to have a study group of farmers that was as representative as possible of Swedish farmers in general.

In the Farm Register, 2319 men meeting the age and geographical criteria described above were identified. The study was restricted to men for two reasons. Since there are not many Swedish women who are occupationally active farmers, it was not possible to have a large enough number with the chosen study design. In the nine counties, 61 women of the included ages were registered in the Farm Register. In addition, many of those women who are active farmers are not listed in the Farm Register since they are active on family farms. One thousand fifty-six men not meeting the criteria of occupational activity in farming described above were excluded. In addition, 42 men for whom address information or other practical uncertainty was at hand were excluded. Ultimately, 1221 farmers from the selected municipalities were included in the study.

Employed farm laborers were not included in the study population for several reasons. There would be few farm laborers accessible in the selected counties. This reflects the agricultural structure in Sweden where family farms predominate. Farm laborers are difficult to identify in official registers. Thus it was not possible to find enough farm laborers for a separate study group for comparison. In addition, since the starting point of the project was the salutogenetic perspective, it was not considered a good idea to include farm laborers in the study population, owing to dilution effects. There is data indicating that the morbidity of farm laborers is somewhere between farmers and other occupational groups in Sweden [196,199].

Referents

For each farmer a reference person was obtained from the National Population Registry, in which all Swedish residents are registered with personal identification numbers. The matching criteria were age, sex and residential area. In addition, the referents were to be occupationally active but in other professions than farming. Occupational activity was established using occupational codes in the most recent population and housing census. Matching by age was done allowing for a mismatch of +/-3 years. Matching by residential area was done by parish, the smallest official administrative unit, in order to ensure that the referents would be living in rural areas, like the farmers. To ensure that the referents would be living in rural areas was considered important since the focus of the project was to study salutogenetic effects of farming and not effects due to the possible rural-urban gradient [98,155,180,185,197].

With this procedure, 1130 referents were sampled. For 91 farmers no matching referent could be found, because the parishes were rural ones with dominance of farming activity. In Lund, where it was especially difficult to find enough referents, a second matching procedure, utilizing all rural parishes available, was performed to generate more referents. Because of this measure, the referents outnumbered the farmers in Lund municipality (some of the farmers had more than one referent). The total study population with its geographical distribution is presented in table 1.

Table 1. Number of individuals sampled by group and geographical area.

Municipality	**Total**	**Farmers**	**Referents**
Enköping	528	279	249
Östhammar	262	138	124
Växjö	346	183	163
Gotland	281	148	133
Lund	245	118	127
Sunne	151	80	71
Karlstad	207	106	101
Härnösand	84	42	42
Östersund	247	127	120
Total	2351	1221	1130

Participation and non-response

The entire study population, consisting of 2351 individuals was informed by postal letter about the study and invited to participate in a survey. The research ethics committee at Karolinska Institutet, Stockholm, approved the study and all participants gave their informed consent.

The participation rate was 76% with 1013 farmers (83%) and 769 referents (68%) participating in the survey. The reasons for non-participation were: deceased after sampling but before examination (2 farmers and 4 referents), illness (13 farmers and 23 referents), could not be retrieved (1 farmer and 10 referents), moved from the area (1 farmer and 6 referents), declined to participate (67 farmers and 90 referents), not at home during the examination period (23 farmers and 25 referents), and unknown reasons (101 farmers and 203 referents). There was no significant difference in age or municipality between participants and non-participants.

The survey

The data collecting survey was conducted from May 1990 through June 1991. A specially trained group of observers divided into two teams traveled to the nine municipalities and performed the survey including questionnaires, interviews, various physical examinations and blood specimens. The observer teams included a physician, several nurses, a secretary and a physiotherapist. Altogether, the investigation was a two-hour procedure per participant. The survey was carried out at local health care centers or other comparable facilities specially set up for the survey. The survey was thus managed as a separate research investigation and was not part of any regular health program. The examinations of farmers and referents were carried out under identical conditions.

Information on symptoms from the musculoskeletal system was assessed by self-administered questionnaire. The participants were asked to indicate (yes or no) if they had ever (more than occasionally) had pain, aches or discomfort in the neck-shoulder area, the low back, hips or knees. Similar symptoms during the last year were also indicated. Symptoms from hands and forearms were assessed as numbness or pricking sensations. The participants were asked to indicate whether they had sought medical advice or treatment (physician, physiotherapist or chiropractor) for the various symptoms, and concerning low back and knee symptoms, whether they had been on sick leave due to the illness.

Symptoms other than musculoskeletal were also assessed in the questionnaires. Effort-related chest discomfort, dyspepsia and symptoms from mucous membranes (eyes, nose, mouth and throat) during the last year were inquired about. Allergic manifestations during lifetime (asthma, hay fever and atopic eczema) were assessed, and standard questions for bronchitis were used.

Self-reported information on reasons for appointments at primary health care centers and hospital admissions throughout life was assessed in a structured interview by an experienced physician. Diagnoses were coded according to the International Classification of Diseases, 9th edition, Swedish version (ICD-9) [1].

Physical work exposures

Work related information was assessed in interviews and questionnaires. Current occupation, number of years in current occupation and type of employment (private, public or self-employed) were noted. Self-reported exposure in current work to vibrations, heavy lifting and difficult working positions were indicated as yes or no without further quantification. Data on the number of working hours and hours of sleep, on physical workload and leisure-time physical activity was obtained in a structured interview. Physical workload was assessed as the average number of hours working in a sitting or standing position, with a moderate, heavy or very heavy workload during an average working day according to Edholm's activity scale [91]. Because of great seasonal variation, the farmers were asked to estimate their average workload over the year. Physical activity during leisure time was assessed as sedentary, slightly active, moderately active or vigorously active on a four-point scale [166]. For physical workload and leisure time activities examples of activities fitting into each category were given. Vacation during the last year was classified as full (4 weeks or more), partial, or few if any days off.

For the farmers, farm size and type of production were assessed and the farmers were asked if they had partners, hired staff and if they used substitutes.

Psychosocial factors

Measurements of psychosocial factors were made using questionnaires. Work-related psychosocial factors were assessed using the Karasek-Theorell job demand-control model [99]. The original 11-item questionnaire was used and the two indices "demands" (item 1-5) and "control" (item10-11) were generated. Satisfaction with current occupation (yes or no) was inquired about and the subject was asked if he had experienced any period of insecurity of working conditions during the past 12 months. Self-reported exposure to stress in the current job was noted as yes or no.

Marital status was classified into four categories; never married, married or cohabiting, divorced or widowed. A social network index was computed by adding the number of people in the household unit, including the respondent, the number of household members having their main meal together, and contacts with children, other relatives and friends. Contacts with children, relatives and friends were graded as often (3 points), sometimes (2 points) and seldom/never (1 point) for each group. In addition, participation in trade union meetings, other organized club meetings, church or other religious meetings and study circles was graded as often (2 points), sometimes (1 point), seldom/never (0 point) and included in the social network index.

The highest educational level attained was assessed on a five-grade scale as compulsory school, vocational school, secondary school, college or university. Other forms of education were recoded into one of the other five forms.

Lifestyle

Detailed information on smoking habits and alcohol consumption was obtained in a structured interview. Smoking was classified as never smoked, currently smoking <10 cigarettes per day, currently smoking ≥10 cigarettes per day, or ex-smoker. Average alcohol intake, computed as grams of pure alcohol consumed per week, was based on frequency of alcohol intake, type of beverage and amount consumed on each occasion.

Weight was measured on a lever balance to the nearest tenth of a kilogram with the participant dressed in light sportswear. Height was measured without shoes to the nearest centimeter with a transportable scale fixed to the lever balance. Body mass index (BMI) was calculated as weight divided by height squared (kg/m^2). Physical work capacity (liter oxygen uptake per minute) was determined by a physiotherapist using a standardized submaximal work test on a bicycle ergometer [226]. Muscle strength was measured in the hand, the arm and the thigh according to the methods used by the Swedish military enrollment board. The various measures for hand, arm and thigh were added to give a total score.

Statistical analyses

Hypothesis

The study hypothesis was that there are differences in reporting frequency of musculoskeletal symptoms between farmers and referents (paper I). The hypothesis further states that this difference in reporting of musculoskeletal symptoms is distributed so that farmers report more musculoskeletal symptoms than do referents. The second study hypothesis was that different frequencies of musculoskeletal outcomes between farmers and referents could be explained by differences in physical work exposures (paper II), psychosocial factors, or lifestyle (paper III). A third hypothesis was that there is comorbidity associated with low back pain (paper IV).

Analytical considerations

The analyses were performed using the SPSS, SAS and JMP software. The analyses were made using case-referent technique. The farmers were designated as the "cases" and the non-farmers the "referents". The outcome variables were dichotomous variables, enabling the use of multiple logistic regression technique in order to adjust for multiple confounding.

Summary statistics, such as means and measures of dispersion, were computed using conventional parametric methods. Simple differences between the groups were tested with Student's *t*-test for continuous data and the chi-square test for ordinal and nominal data. Logistic regression was used to compute odds ratios (OR) and their 95% or 99% confidence interval (95% CI, 99% CI) in crude and adjusted analyses to express differences in outcomes between the groups. The referents were systematically designated the odds 1.0, and the presented odds for the farmers were set in relation to this. Only two-tailed tests were used. A p-value of 0.05 was regarded as statistically significant in Papers I, II, IV, and the significance level was set to 0.01 in paper III to account for the large number of tests. Very small p-values are given as <0.0001, even if they were actually smaller.

The partial non-response rate (missing values in data from responders) was generally low, below 1% for physical exposure variables (paper II) and below 3 % for most psychosocial variables (paper III), and it is therefore not presented in tables. Owing to technical problems with the equipment, 8.6% of the subjects are missing data on arm muscle strength. Eighty-seven persons (6.6%) did not perform the submaximal work test owing to disability or clinical precaution, and almost 10% of the job-demand questionnaires were incomplete.

The analyses have been done both conditionally (keeping the matched pairs together) and unconditionally (on the complete study population treating the groups as two cohorts). The results were similar with the two approaches. Since some farmers and referents did not have a matching person, due to non-participation, the unconditional analyses rendered somewhat greater statistical power. The results in paper II present results from conditional analyses and the other papers (I, III, IV) present results from unconditional analyses.

Multiple logistic regressions

In paper II, backward elimination of non-significant exposure variables was used until all remaining variables were significantly related to the outcome. Farmer-referent status was kept in the model irrespective of significance level since this odd was the main result. Workload units and muscle strength units were divided by 100, number of years in the current job was divided by 10 and BMI was divided by 5 before entering this data in the regression analysis, to facilitate the interpretation of the odds ratios. Leisure time activity showed different trends between farmers and referents in stratified analyses. The interaction between leisure-time activity and farmer-referent status was significant and an interaction term was therefore included in the final model.

Some variables were dichotomized before entering the variables in the regression models in paper III. The demand variable was split on the median. Control of work was skewed towards high values. High control therefore constitutes 8 points (versus 2-7 points). BMI was dichotomized on ≤ 25 kg/m^2 versus > 25 kg/m^2. Alcohol consumption was dichotomized on 60 grams of pure alcohol per week. Marital status was dichotomized on single (never married, divorced or widowed) versus married/cohabiting. The analyses were repeated with continuous data without dichotomization, yielding similar results. In order to facilitate interpretation of the results, the models with dichotomous variables are presented. Marital status had the opposite effect among farmers and referents and therefore an interaction term was included in the adjusted analyses.

In paper IV, the low back pain outcome was graded into three levels namely never low back pain, previous low back pain and low back pain during the past year. The analyses of associations between low back pain and other symptoms and diagnoses were made for the total study population and stratified on farmers and referents. Respiratory and digestive disease scores were generated. To estimate the extent to which the two scores could "explain" the variation of low back pain reporting, the correlation coefficient squared (r^2), the standard measure, was used. However, it is heavily influenced by random variation. For this reason the area under the curve of a receiver operator characteristic (ROC) diagram, with sensitivity rate on the vertical axis and inverted specificity rate on the horizontal axis, was used as an additional measure. This measure is far less influenced by random variation and other bias. The "degree of explanation" (ROC %) was calculated as: (area fractile - 0.5) x 2 x 100.

Results

Characteristics of the study population

The mean age of the participants in the study was 50.3 years, with no age difference between farmers and referents (Table 2). BMI was similar in the two groups. Fewer farmers (17%) than referents (31%) were current smokers ($p<0.0001$), and the farmers reported lower alcohol consumption than the referents. The majority of the farmers were self-employed. Some farmers had part-time jobs in other businesses and therefore reported that they were employed. The main types of production among the farmers were dairy production (44%), crops growing (23%), swine confinement (12%) and cattle raising (12%). The average farm size was 56 hectares, approximately 112 acres. Fifteen percent of the farmers had hired staff, 18% had a partner in their farm company and 23% reported that they used substitutes.

Table 2. Characteristics of the study population.

	Farmers (N=1013)		**Referents** (N=769)		
	Mean or %	*SD*	*Mean or %*	*SD*	*p*
Age	50.3	6.0	50.3	6.0	0.770
Body mass index (kg/m^2)	26.3	3.2	26.6	3.2	0.071
Current smokers	17.5		30.9		<0.0001
Alcohol consumption (g/week)	20.2	24.9	31.1	33.2	<0.0001
Self-employment	92.0		18.6		<0.0001

Among the referents 19% were self-employed, 43% were employed in private companies and 39% in the public sector. The majority of the referents had blue-collar jobs (59%). Work in various manufacturing industries (38.2%) dominated, followed by transportation and communications (10.4%), the service sector (6.6%), and others (3.7%). Forty-one percent of the referents had white-collar jobs, mainly in qualified white-collar professions (23.7%) followed by administrative jobs (8.6%), commercial jobs (6.0%) and health care (2.7%).

Physical work exposure varied significantly between farmers and referents (Table 3). Farmers reported higher workloads and more farmers were exposed to vibrations, heavy lifting and difficult working positions. The farmers worked more hours per day, slept longer and had been more years in their current job. Sixty-four percent of the farmers and 8.7% of the referents reported few if any days of vacation the year before the survey. The farmers reported less physical activity in their leisure time but still had higher physical capacity as measured with the submaximal work test. No significant difference in total muscle strength was found between farmers and referents but the farmers had better hand and arm strength.

Table 3. Prevalence of physical work exposures and other physical variables among farmers and referents.

	Farmers (N=1013)		**Referents** (N=769)		
	Mean or %	*SD*	*Mean or %*	*SD*	*p*
Workload, units	236.7	69.4	142.2	71.9	<0.0001
Vibrations, %	75.0		32.4		<0.0001
Heavy lifting, %	86.3		38.8		<0.0001
Difficult working positions, %	75.0		41.0		<0.0001
Work hours	10.2	2.2	8.4	2.2	<0.0001
Sleep hours	7.1	0.8	7.0	0.9	<0.0001
Years in current job	24.7	11.5	19.6	10.6	<0.0001
No vacation last year, %	64.4		8.1		<0.0001
Leisure-time activity, score	1.7	0.7	2.1	0.7	<0.0001
Sedentary, %	39.5		14.8		
Slightly active, %	48.7		66.5		
Moderately active, %	9.9		15.4		
Vigorously active, %	1.9		3.3		
Muscle strength, total, units	2187.3	377.7	2142.2	365.4	0.016
Hand, units	619.7	112.2	607.4	107.1	0.020
Arm, units	427.9	96.6	407.4	94.3	<0.0001
Thigh, units	610.7	147.9	606.4	144.8	0.533
Physical capacity, l/min	3.0	0.6	2.7	0.6	<0.0001

Psychosocial factors also differed significantly between farmers and referents (Table 4). The farmers reported higher work demands and higher work control. Many more farmers than referents had experienced insecurity about their working conditions during the last year. The majority of the study participants were married or cohabiting. However, more farmers than referents were single/never married while fewer farmers were divorced. The farmers had a significantly higher social network score according to the index described above. On average, the farmers had lower educational level than the referents although fewer farmers had only compulsory schooling.

Table 4. Prevalence of psychosocial variables among farmers and referents.

	Farmers (N=1013)		**Referents** (N=796)		
	Mean or %	*SD*	*Mean or %*	*SD*	*p*
Work-related variables					
Work demand, score	13.2	2.4	12.0	2.8	<0.0001
Work control, score	7.3	1.1	6.7	1.4	<0.0001
Work satisfaction, %	89.4		88.1		0.388
Work insecurity, %	57.9		23.4		<0.0001
Work stress, %	66.1		64.8		0.572
Social variables					
Marital status					<0.0001
Never married, %	10.2		7.3		
Married, %	86.4		86.9		
Divorced, %	2.6		5.2		
Widowed, %	0.8		0.5		
Household size	3.2	1.3	2.8	1.2	<0.0001
Social network, score	16.4	3.8	14.4	3.6	<0.0001
Educational level					<0.0001
Compulsory school, %	39.8		43.9		
Vocational school, %	38.9		22.3		
Secondary school, %	12.1		8.7		
College, %	3.9		11.2		
University, %	5.3		13.9		

Musculoskeletal symptoms, consultations and sick leave (Paper I)

The vast majority of the study participants (89%) reported one or several musculoskeletal symptoms during their lifetime and a larger proportion of farmers than referents reported symptoms (OR=1.51, 95% CI 1.13-2.03) (Table 5). The farmers reported significantly more symptoms from hands and forearms, low back and hips. No significant difference was found concerning neck and shoulder symptoms and knee symptoms. Despite more musculoskeletal symptoms, the farmers had not sought medical advice or been treated more often than the referents and fewer farmers than referents reported sick leave owing to low back problems or knee problems. No significant difference between farmers and referents regarding health care utilization for musculoskeletal disorders as measured by appointments at primary health care centers or hospital admissions according to the interview data was found.

No differences in the frequency of reported symptoms between farmers in various types of farm production were found regarding neck and shoulder problems, hand and forearm problems, low back pain and hip problems. However, farmers in dairy production reported more knee problems than did other farmers, 51.4% vs. 43.4%, $p<0.05$, and those in cattle raising reported fewer knee problems, 37.9% vs. 48.2%, $p<0.05$. The presence of substitutes was positively correlated to knee symptoms. Hired staff, partners or use of substitutes was not associated with any other musculoskeletal symptom. Farm size showed no relationship with musculoskeletal symptoms.

Can differences in physical work exposures explain differences in musculoskeletal symptoms between farmers and referents? (Paper II)

Physical workload, vibrations, heavy lifting and difficult working positions were positively related to all types of musculoskeletal symptoms in crude analyses. Years in current job, self-employment, little vacation last year, total muscle strength and physical capacity were correlated to low back pain and hip pain. Number of working hours per day, sleeping hours and leisure-time activity were not correlated to any symptom.

Table 5. Prevalence of musculoskeletal symptoms, medical consultations and sick leave among farmers and referents.

	Farmers		**Referents**			
	n	*%*	*n*	*%*	*OR*	*95% CI*
Neck and shoulder						
Ever had pain	574	56.8	408	53.2	1.16	0.96-1.40
Had pain last year	467	46.5	332	43.7	1.12	0.93-1.35
Sought medical advice	321	31.9	245	32.0	0.99	0.81-1.21
Hands and forearms						
Ever had numbness or paresthesia	361	35.7	223	29.2	1.35	1.10-1.65
Ever had nocturnal aches	162	16.0	93	12.2	1.38	1.05-1.81
Sought medical advice	104	10.3	88	11.6	0.88	0.65-1.19
Wrist nerve entrapment surgery	9	0.9	17	2.2	0.39	0.17-0.89
Low back						
Ever had low back pain	686	68.3	445	58.3	1.54	1.26-1.87
Low back pain during past year	473	47.2	293	38.6	1.42	1.17-1.72
Sought medical advice	454	45.2	331	43.4	1.08	0.89-1.30
Ever sick-listed due to low back pain	288	28.7	271	35.6	0.73	0.60-0.89
Hips, groins and thighs						
Ever had hip pain	318	31.7	160	21.0	1.74	1.40-2.17
Ever had groin-thigh pain	139	13.9	96	12.6	1.12	0.85-1.48
Hip, groin or thigh pain during past year	203	20.2	116	15.2	1.41	1.10-1.81
Sought medical advice	111	11.1	77	10.1	1.11	0.81-1.50
Had hip surgery	2	0.2	3	0.4	0.51	0.08-3.03
Knees						
Ever had pain	471	46.7	338	44.2	1.11	0.92-1.34
Pain during past year	305	30.3	202	26.5	1.20	0.98-1.48
Sought medical advice	252	25.0	197	25.8	0.96	0.77-1.19
Sick-listed due to knee problems	141	14.0	138	18.1	0.74	0.57-0.95
Had knee surgery	47	4.7	37	4.9	0.96	0.62-1.49
Any symptom	*918*	*90.6*	*665*	*86.5*	*1.51*	*1.13-2.03*

Multiple analyses revealed which variables were independently related to each of the musculoskeletal symptoms studied (Table 6). Difficult working positions were associated with symptoms from neck and shoulders, and leisure-time activity was associated with fewer symptoms among the referents but not among the farmers. After adjustment for the influence of these factors the farmers reported fewer neck and shoulder symptoms than

Table 6. Odds ratios (OR) with 95% confidence intervals (95%CI) for lifetime incidence of neck and shoulder, hand and forearm, low back, hip and knee symptoms adjusted for physical exposure variables. Multiple logistic regression models using backward elimination procedures.

	Neck/shoulder		**Hand/forearm**		**Low back**		**Hips**		**Knees**	
	OR	*95%CI*	*OR*	*95%CI*	*OR*	*95%CI*	*OR*	*95%CI*	*OR*	*95%CI*
Farmer versus referent	0.62	0.47-0.82	0.85	0.62-1.16	1.51	1.02-2.23	1.46	1.11-1.93	1.17	0.82-1.66
Workload per 100 units			1.33	1.05-1.69	0.67	0.52-0.85				
Vibrations			1.63	1.18-2.24			1.51	1.14-2.00	1.49	1.13-1.95
Heavy lifting					1.59	1.11-2.28			1.43	1.06-1.93
Difficult working positions	1.84	1.44-2.35	1.43	1.03-1.98	1.79	1.30-2.45				
Work hours			0.92	0.84-0.99	1.11	1.03-1.21				
Sleep hours			0.84	0.72-0.97						
Time in current job per 10 yrs					1.21	1.08-1.36			1.13	1.01-1.25
Self-employment					0.59	0.41-0.87			0.55	0.38-0.78
Leisure-time activity										
Farmers	1.20	0.66-2.16								
Referents	0.68	0.53-0.88								
Body mass index per 5 kg/m^2			1.32	1.07-1.61						
Total muscle strength per 100 units			0.94	0.90-0.97						
Physical capacity					1.46	1.18 -1.81				

Variables entered in step 1 for each separate outcome: Farmer versus referent, workload /100, vibrations, heavy lifting, difficult working positions, work hours, sleep hours, time in current job /10, self-employment, leisure-time activity, vacation last year, body mass index /5, smoking, total muscle strength /100 and physical capacity.

the referents (OR=0.62, 95% CI 0.47-0.82). The higher prevalence of reported symptoms from hand and forearms among farmers in crude analyses could be completely explained as related to physical work exposures and overweight.

Heavy lifting, difficult working positions, number of working hours per day, years in the current job and physical capacity were all associated with low back pain, whereas workload and self-employment had a negative relation to low back pain. After adjustment for the influence of these factors, the farmers still had a higher risk of low back pain than the referents (OR=1.51, 95% CI 1.02-2.23).

Vibrations were the only physical factor independently associated with hip symptoms. The effect of vibrations did not, however, explain the higher odds for hip symptoms (OR=1.46, 95% CI 1.11-1.93) among the farmers. Vibrations, heavy lifting and years in current job were associated with knee symptoms, whereas self-employment had a negative correlation with knee symptoms. After adjustment for the influence of these factors, there was no clear difference in prevalence of knee symptoms between farmers and referents.

Can differences in psychosocial factors or lifestyle explain differences in low back pain between farmers and referents? (Paper III)

Farmers reported significantly more low back pain even after adjustment for the influence of psychosocial factors (OR=1.47, 99% CI 1.04-2.09) (Table 7). Work insecurity and overweight (BMI >25 kg/m^2) were positively related to low back pain whereas work control and smoking showed an inverse relationship.

After adjustment for psychosocial factors, the farmers tended to report more low back consultations than the referents. Alcohol consumption of more than 60 g/week and overweight were significantly related to low back consultations, and work demand and being single showed a tendency in the same direction.

The farmers' low odds of sick leave due to low back pain increased somewhat after adjustment for psychosocial factors. Overweight was positively related to sick leave whereas work control had a negative relation to sick leave. Work insecurity tended to be related to an increased risk of sick leave. Educational level and social network were not related to any of the low back outcomes either in crude or in adjusted analyses.

Table 7. Crude and adjusted odds ratios (OR) with 99% confidence intervals (99% CI) for low back pain, consultations and sick leave for farmers as compared to referents. Adjustments were made for all the variables listed in the table and for interaction between farmer-referent status and marital status.

	Low back pain				**Low back consultation**				**Low back sick leave**			
	Crude		Adjusted		Crude		Adjusted		Crude		Adjusted	
	OR	*99% CI*	*OR*	*99% CI*	*OR*	*99% CI*	*OR*	*99% CI*	*OR*	*99% CI*	*OR*	*99% CI*
Farmers	1.54	1.19-1.99	1.47	1.04-2.09	1.07	0.84-1.38	1.23	0.87-1.73	0.73	0.56-0.95	0.81	0.57-1.17
Work demands, >median	1.47	1.12-1.92	1.26	0.94-1.68	1.32	1.02-1.72	1.27	0.95-1.68	1.12	0.85-1.48	1.15	0.85-1.57
Work control, >median	0.88	0.68-1.15	0.77	0.57-1.03	0.91	0.71-1.18	0.84	0.63-1.11	0.70	0.54-0.92	0.67	0.50-0.90
Work insecurity	1.66	1.28-2.17	1.42	1.04-1.92	1.32	1.03-1.70	1.23	0.92-1.65	1.17	0.89-1.53	1.31	0.95-1.80
Being single	1.06	0.73-1.55	1.56	0.78-3.14	0.92	0.64-1.32	1.88	0.96-3.67	0.74	0.49-1.11	1.47	0.75-2.90
Social network, >median	1.00	0.78-1.30	0.92	0.68-1.25	0.86	0.67-1.10	0.88	0.65-1.18	0.86	0.66-1.12	0.92	0.67-1.23
Educational level	1.04	0.94-1.15	1.03	0.92-1.56	0.97	0.88-1.07	0.96	0.86-1.08	0.97	0.87-1.08	0.96	0.85-1.08
Smoking habits	0.73	0.54-0.98	0.72	0.52-1.01	0.97	0.73-1.30	0.97	0.70-1.36	1.13	0.83-1.54	1.02	0.72-1.45
Alcohol consumption, >60g/week	1.18	0.76-1.83	1.33	0.81-2.16	1.59	1.05-2.40	1.64	1.04-2.61	1.38	0.90-2.11	1.35	0.84-2.16
Body Mass Index, >25kg/m^2	1.23	0.95-1.60	1.36	1.02-1.82	1.50	1.16-1.94	1.66	1.25-2.21	1.43	1.08-1.88	1.51	1.10-2.05

Since practically all the farmers were self-employed, it was not possible to adjust directly for this factor. To disentangle the effect of self-employment, a categorical variable was constructed with employed referents as the reference category. Separate OR's were then computed for farmers and self-employed referents (Table 8). Farmers still tended to have an increased rate of low back pain as compared to referents when the influence of self-employment and the other psychosocial variables and lifestyle were taken into account. Self-employed referents tended to have lower odds of low back pain as compared with employed referents. There were no differences in low back consultations between the groups either before or after adjustment. The farmers' low odds for sick leave due to low back pain remained low, although not significantly so, after self-employment and psychosocial factors were considered. The self-employed referents tended to have even lower odds for sick leave.

Low back pain and comorbidity (Paper IV)

Some differences in reporting other symptoms than musculoskeletal symptoms were found between farmers and referents. Fewer farmers than referents reported chest discomfort the past year (11.6% vs. 16,6%, p=0.003) and fewer farmers reported dyspepsia (29.2% vs. 34.4%, p=0.018). No difference in reporting of allergic manifestations, bronchitis or skin problems were found. Twelve per cent of the farmers (n= 121) and less than two per cent of the referents (n=13) reported work-related fever attacks (p<0.0001). Farmers reported significantly fewer diagnoses at primary care appointments than referents for psychiatric disorders, eye-related disorders, digestive disorders and skin disorders but significantly more injuries requiring primary health care service. Fewer farmers than referents reported hospitalization due to psychiatric disorders (0.4% vs. 2.0%, p=0.002) and urinary tract disorders (3.6% vs. 6.1%, p=0.001).

The prevalence of other musculoskeletal symptoms was associated with low back pain (Table 9). The associations were similar for farmers and referents. Chest discomfort, dyspepsia, symptoms from mucous membranes, skin problems and work-related fever attacks were associated with low back pain while allergic symptoms and bronchitis were not. Low back pain was associated with primary health care appointments for digestive disorders in the entire study group. In addition, low back pain was associated with primary and hospital care for ear-related disorders, and with miscellaneous disorders in primary care among referents but not in the combined study group. The association between low back pain and number of work-related fever attacks indicates a dose-response-relationship (Table 10).

Table 8. Crude and adjusted odds ratios (OR) with 99 % confidence intervals (99%CI) for low back pain, consultations and sick leave for farmers and self-employed referents with reference to employed referents. Adjustments were made for work demand, work control, work insecurity, marital status, social network, educational level, smoking habits, alcohol consumption, body mass index and interaction between farmer-referent status and marital status.

	Low back pain				**Low back consultation**				**Low back sick leave**			
	Crude		Adjusted		Crude		Adjusted		Crude		Adjusted	
	OR	*99%CI*	*OR*	*99%CI*	*OR*	*99%CI*	*OR*	*99%CI*	*OR*	*99%CI*	*OR*	*99%CI*
Employed referents	1.00	-	1.00	-	1.00	-	1.00	-	1.00	-	1.00	-
Farmers	1.46	1.11-1.93	1.37	0.95-1.98	1.04	0.80-1.36	1.14	0.80-1.63	0.70	0.53-0.93	0.76	0.52-1.11
Self-employed referents	0.65	0.40-1.06	0.68	0.38-1.24	0.70	0.42-1.17	0.70	0.38-1.29	0.60	0.35-1.04	0.64	0.34-1.23

Table 9. Associations between low back pain and other symptoms, causes of primary care and hospital admissions for farmers and referents. Odds ratios (OR) with 95% confidence intervals (95% CI) computed with ordinal logistic regression with adjustment for educational level, smoking habits, body mass index, physical workload, difficult working positions, work demands and household size. Significant relationships are shown in bold type.

	Low back pain					
	Farmers		Referents		Total	
	OR	*95% CI*	*OR*	*95% CI*	*OR*	*95% CI*
Symptoms						
Neck-shoulder pain	**1.99**	**1.54-2.57**	**2.09**	**1.55-2.83**	**2.04**	**1.68-2.48**
Hand-forearm pain	**1.80**	**1.37-2.36**	**1.74**	**1.24-2.44**	**1.78**	**1.44-2.20**
Hip pain	**2.23**	**1.68-2.96**	**3.19**	**2.13-4.76**	**2.53**	**2.01-3.18**
Knee pain	**1.81**	**1.40-2.34**	**1.78**	**1.32-2.41**	**1.77**	**1.46-2.15**
Chest discomfort	**2.04**	**1.32-3.14**	1.50	0.98-2.29	**1.69**	**1.29-2.28**
Dyspepsia	**1.50**	**1.13-1.99**	**2.28**	**1.66-3.13**	**1.76**	**1.43-2.17**
Mucous membrane	**1.80**	**1.34-2.42**	**1.54**	**1.09-2.18**	**1.67**	**1.33-2.08**
Asthma	0.70	0.38-1.27	1.13	0.56-2.27	0.85	0.54-1.33
Hay fever	0.93	0.59-1.46	1.24	0.72-2.15	1.02	0.72-1.44
Atopic eczema	1.27	0.56-2.91	1.62	0.70-3.72	1.42	0.79-2.54
Bronchitis	1.25	0.64-2.43	1.24	0.50-3.04	1.25	0.73-2.13
Skin problems	**1.45**	**1.02-2.06**	1.44	0.98 -2.12	**1.44**	**1.11-1.87**
Work-related fever attacks	**1.75**	**1.16-2.66**	2.71	0.71-10.3	**1.96**	**1.32-2.90**
Primary care						
Infectious diseases	0.76	0.29-1.97	1.01	0.40-2.55	0.93	0.48-1.80
Endocrine disorders	1.23	0.55-2.76	0.66	0.28-1.57	0.93	0.53-1.66
Psychiatric disorders	1.64	0.80-3.37	0.94	0.49-1.81	1.20	0.75-1.92
Eye-related disorders	1.63	0.88-3.04	1.02	0.55-1.88	1.31	0.85-2.02
Ear-related disorders	0.74	0.45-1.20	**1.69**	**1.00-2.86**	1.10	0.77-1.56
Circulatory disorders	0.70	0.48-1.04	1.01	0.64-1.59	0.81	0.60-1.09
Respiratory disorders	1.35	0.82-2.22	0.85	0.50-1.45	1.06	0.74-1.51
Digestive disorders	**1.64**	**1.13-2.38**	**1.65**	**1.12-2.45**	**1.63**	**1.25-2.13**
Urinary tract disorders	0.75	0.44-1.29	1.26	0.72-2.22	0.94	0.64-1.38
Skin disorders	0.64	0.27-1.54	1.35	0.66-2.76	0.99	0.57-1.71
Injuries and intoxication	1.18	0.91-1.53	1.16	0.83-1.62	1.20	0.98-1.48
Miscellaneous	1.14	0.59-2.21	**2.31**	**1.13-4.70**	1.59	0.98-2.57
Hospital admissions						
Infectious diseases	0.82	0.37-1.83	0.91	0.37-2.22	0.90	0.50-1.64
Endocrine disorders	0.31	0.08-1.16	1.04	0.32-3.40	0.58	0.24-1.40
Psychiatric disorders	1.10	0.18-7.19	1.18	0.39-3.53	1.13	0.44-2.87
Eye-related disorders	1.63	0.88-3.04	1.02	0.55-1.88	1.31	0.85-2.02
Ear-related disorders	0.74	0.45-1.20	**1.69**	**1.00-2.86**	1.10	0.77-1.56
Circulatory disorders	0.94	0.52-1.70	0.89	0.47-1.68	0.93	0.61-1.43
Respiratory disorders	1.77	0.89-3.50	1.33	0.72-2.49	1.43	0.91-2.24
Digestive disorders	0.93	0.65-1.33	0.96	0.64-1.43	0.94	0.72-1.22
Urinary tract disorders	0.83	0.43-1.62	1.31	0.71-2.39	1.04	0.67-1.63
Skin disorders	1.77	0.18-16.9	4.39	0.53-36.5	2.87	0.62-13.2
Injuries and intoxication	0.93	0.69-1.27	1.19	0.82-1.73	1.05	0.83-1.32
Miscellaneous	1.14	0.52-2.49	1.47	0.53-4.08	1.30	0.70-2.42

Table10. Associations between low back pain during the past year and work-related fever attacks adjusted for farmer-referent status, educational level, smoking habits and body mass index in the total study population. (OR = odds ratio, 95% CI = 95% confidence interval)

	Low back pain		
	n	*OR*	*95% CI*
Number of work-related fever attacks			
no attacks	1583	1.00	-
1-2 attacks	54	1.36	0.78-2.36
3 or more attacks	63	2.15	1.27-3.65

A respiratory disease score was computed as the sum of the codes for chest discomfort (0 or 1), symptoms from mucous membranes in the eye, nose and throat area (0 or 1) and work-related fever attacks (0 or 1), total score range 0-3. A digestive disease score was computed as the sum of the codes for dyspepsia (0 or 1) and primary health care visits for digestive disorders (0 or 1), total score range 0-2. In Figure 1, low back pain prevalence rates are shown with respect to various combinations of respiratory disease and digestive disease score. Subjects with a respiratory disease score = 0 and a digestive disease score = 0 had a low back pain past (one) year incidence of 35 % and a lifetime low back pain incidence of 55 %. The higher the scores and the combination of scores, the higher the low back pain incidence. Those with respiratory score = 3 and digestive score = 2 had a one year incidence of 79 % and a lifetime low back pain incidence of 92 %.

How variation in the respiratory disease and digestive disease scores could explain variation in the one-year incidence of low back pain and lifetime incidence of low back pain is shown in Table 11. With the r^2 measure, the degree of explanation was moderate, 2.8% or less. In the ROC analyses the explanatory effects were larger, 11-21%. Using the two scores and all adjustment variables the degree of explanation with the r^2 method was 5-6 % and with the ROC method 32%.

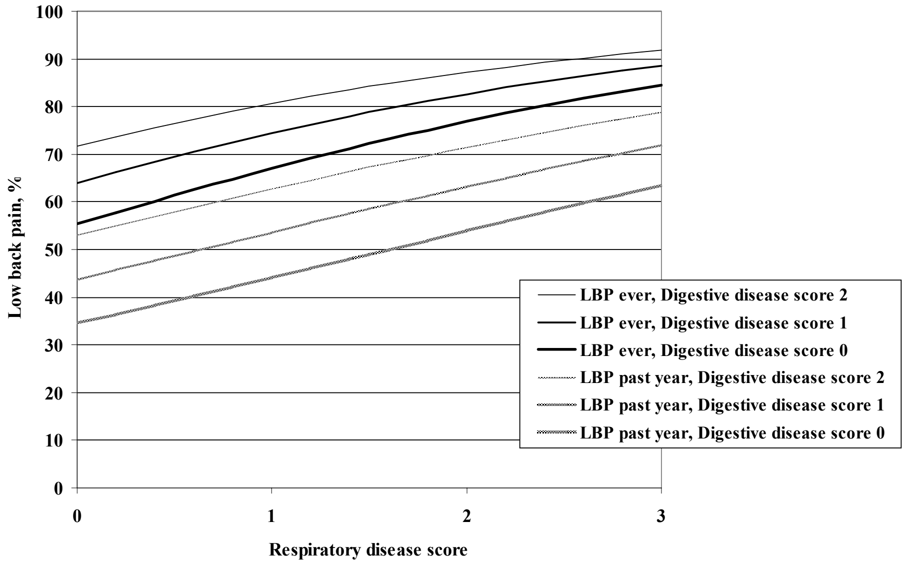

Figure 1. Prevalence rates of low back pain ever in life and during the past year by respiratory disease score and digestive disease score.

Table11. Degrees to which variation in independent variables explain variation in the prevalence or low back pain (LBP). r^2 = correlation coefficient squared, ROC% = proportion of receiver operating characteristic diagram area under the sensitivity-specificity curve.

	Degree of explanation			
	LBP past year		**LBP ever**	
Independent variables	r^2	*ROC%*	r^2	*ROC%*
Respiratory disease score alone, %	1.6	13.7	2.0	16.2
Digestive disease score alone, %	1.1	11.3	1.0	11.0
Respiratory and digestive disease score, %	2.4	19.2	2.8	21.4
Respiratory and digestive disease score + Education + smoking + body mass index + physical work exposure + psychosocial factors, %	5.3	31.5	5.8	32.3

Discussion

Pain and other symptoms from the musculoskeletal system that cannot be assigned to specific diseases such as rheumatic disorders, or to injuries, have traditionally been attributed to physical exposure and strenuous working conditions. The concept was supported by early studies back in the 1950s and 60s reporting high frequency of degenerative changes in the lumbar spine of industrial workers [87]. Later investigations using magnetic resonance imaging have shown that spinal degenerative changes are common in the general population, and associations with occupational activity have not been confirmed [20,171]. The number of individuals reporting musculoskeletal symptoms has probably increased in recent decades, while during the same period functional disability due to musculoskeletal problems have decreased [181]. This is somewhat difficult to understand since there have been considerable improvements in physical work environments. Fewer workers are exposed to heavy lifting and awkward working posture. In addition, musculoskeletal symptoms are also frequent in occupations with relatively low physical requirements.

The purely anatomical-physiological view addressing musculoskeletal problems, mainly low back pain, has been expanded to include more detailed physical factors and neurochemical-biomecanical models. Today, a broad multifactorial approach, also including various psychosocial factors in combination with the aforementioned factors, is dominant.

The association between physical workload factors and musculoskeletal disorders has been analyzed in numerous studies, with results sometimes divergent and difficult to interpret [15,28,70,83,95,220]. Causal relationships are, however, difficult to demonstrate and this means that the general assumption that heavy physical load really causes low back pain and other musculoskeletal symptoms is in fact a hypothesis. At the same time it is evident that the human body is designed for motion and there is increasing evidence of the health promoting effects of physical activity with regard to musculoskeletal disorders [134,165,189].

Various other factors in addition to physical loads are evidently associated with musculoskeletal problems. Several studies have shown that psychosocial work factors, such as repetitive and monotonous work tasks, dissatisfaction with work, stress and poor relations to work mates and supervisors are related to an increased risk of musculoskeletal symptoms, especially from neck and shoulders [16,17,93]. Psychological factors seem to be of importance as well [121]. However, causal relationships are also difficult to demonstrate with regard to psychosocial factors. There are many studies on stressors and muscular symptoms, and explanatory models involving central hyperexcitability [117], the Cinderella-hypothesis [60,225], etc. have been proposed.

Another problem in research on psychosocial factors and musculoskeletal disorders is related to diagnostic definitions. What is, for example, "low back pain"? Low back pain "outcomes" might be reported symptoms of different duration and defined in various ways. Other outcomes when studying low back pain might be health care utilization, disability or registered sickness absenteeism. Pain is a subjective phenomenon. Numerous individual and situational factors modify pain thresholds, realization about symptoms and care-seeking behaviors. A number of current research concepts may be noted. For example that "low back pain" is 1) the result of a disease, 2) a combination of psychosocial factors and disease or 3) that psychosocial factors are predominant indirect "causes".

Although back and neck pain is so frequently encountered, the direct etiology is not known. Epidemiological research has revealed many associations with physical workload, psychosocial factors and individual factors. Physiological mechanisms in the muscles and the nervous system are being elucidated in more and more detail [63]. It is probable that there are different causes of the development of musculoskeletal symptoms, care-seeking behaviors and sick leave. Sick leave is dependent on many other factors beside medical diagnoses stated on certificates [50,122,174].

It is of interest to study farmers with regard to musculoskeletal disorders since farmers as a group are exposed to strenuous physical work and therefore, according to the hypothesis, should have a high frequency of musculoskeletal symptoms. At the same time farmers have low morbidity rates in registered data, and care-seeking and sick leave rates are assumed to be low.

Methodological discussion

This thesis is based on a rural and farming population, sampled for a study of salutogenesis. The overall question was why do farmers have low morbidity and mortality for several disease categories? [148,183,197]. The design was a prospective cohort study with farmers and matched rural referents. In time, analyses using follow-up data may contribute to better understanding of health promoting factors in general. This thesis, however, is based on cross-sectional baseline data, and this must be recognized when interpreting the results. Cross-sectional studies can deal with large data sets but determination of causality is not possible when studied variables and outcomes are registered at the same time.

The material has several important quality strengths. It is population-based. The study population was carefully restricted to assure the occupational affiliation to farming among the farmers. A careful matching procedure to assure an adequate control group was performed to avoid confounding due to rural-urban health gradients, age and sex. Restriction of the study population and matching for possible confounding factors are means of avoiding confounding. If the confounding factor does not vary between the exposed and non-exposed, it cannot then, by definition, be a confounder. When it is not possible to match for potential confounders, stratification of the results can be performed. However, a fundamental problem with stratification is the inability to control for several potential confounders simultaneously. Multivariate statistical techniques have been developed to allow estimation of associations with simultaneous adjustment for several confounding variables [76].

All multivariate analyses involve the construction of a mathematical model to describe the association between exposure and outcome, and there are general assumptions underlying their applicability. When studying binary outcomes such as diseased-not diseased, multiple logistic regression analyses are used to estimate associations adjusted for several confounding factors simultaneously. Possible effect modification from variables included in the model can be handled by assessing interaction between variables, and the effect of interactions can be controlled for in the model.

The interrelationships between exposures, outcomes and other factors were described using multivariate modeling. Logistic regressions provide an estimate of the relative risk as an odds ratio. The odds ratio is a useful indicator of the strength of the relationship. When handling rare outcomes (diseases), the odds ratio approximates the relative risk, but when addressing common conditions the odds ratio gives a numerically stronger impression of the relationship [129]. The odds ratio is essential for estimating differences between groups and so it is applicable in studies of common conditions. Multivariate analyses hence provide efficient mathematical modeling of large data sets when handling several variables at the same time. One disadvantage of the technique is that it can be difficult to clearly understand the data analysis and to interpret the results. Stratified analyses are helpful in conjunction with multivariate analyses in the interpretation of data.

Another important strength of this study is the size of the material, which allows for the use of powerful statistical multivariate methods with maintained statistical power and precision. In addition, the quality of the information gathered in the survey is considered high, owing to the very low partial non-response for most variables. The survey was conducted as a special research investigation with specially trained personnel, something that contributed to the data quality, as compared with research materials gathered in continual medical or health-related activities where regular health personnel contribute data. The ambition was to use previously validated instruments when possible, for example the Edholm activity scale for general physical workload [91] and Karasek and Theorell work demand-control model for psychosocial work-related factors [99]. For other variables we wanted to capture such as social networks, no useful instrument suitable for a rural farming population was found. Relevant questions were assembled and a social network index as described above and in paper III was constructed.

The study also has its limitations. One important limitation is the relatively vague definition of musculoskeletal symptoms. The lifetime prevalence of symptoms was assessed, and the questions stated that this should not include transient symptoms. There are broad possibilities of different responders interpreting this in different ways. Questions on symptoms during the past year were also used but the results of the two outcomes, lifetime symptoms or symptoms during the past year were similar.

The problem with vague definitions of symptoms is especially important in studies on prevalence and incidence rates. When rates are compared between studies, it is essential that comparable methods have been used. However, in this study, the focus was differences in reporting symptoms between two groups (farmers and referents) examined under identical conditions. Relatively vague definitions of outcomes and variables might be acceptable if no systematic bias regarding the variables is at hand. The fact that the study was part of a large project with a broad focus on health, in which musculoskeletal disorders are just one aspect, limited the possibilities of gathering very detailed data. On the other hand, the possibility of combining data from broad areas is valuable.

The frequency of low back pain has been described as both incidence rates and prevalence rates. The use of the terms incidence and prevalence is somewhat imprecise owing to the fact that most of the reported symptoms and problems cannot be described in terms of distinct prevalence or incidence. Perhaps the most exact way of defining the rates would have been to use the terms cumulative one-year incidence and cumulative lifetime incidence.

Recall bias, resulting in nonrandom missclassification, is an important problem in studies based on collected retrospective data [61,76,106]. Having a disease or symptoms, which one believes might be related to various exposures, renders the individual more prone to remembering such exposures prior to the symptom. Structured interviews are preferable to self-administered questionnaires for obtaining reliable information on physical exposure [207]. Sometimes data based on interviews or questionnaires may be compared with register data as a quality control. We have found that interview-based information on previous hospital admissions in our material has very high congruity with register data [186].

The problem with recall bias is also considerable in case-control studies although this type of study has other advantages, especially when addressing diseases that are more unusual. When analyzing the risk of a certain disease or symptom in a defined group it is essential to have an adequate control group for comparison. The estimated risk in a study group needs to be set in relation to a defined control group when increased or decreased risks are discussed. Many studies reporting high prevalence of musculoskeletal problems in various occupations have severe limitations in this respect.

Result discussion

Several studies have demonstrated a relationship between hip osteoarthritis and farming [40,125,195], but the causal mechanisms are still unclear [202]. High prevalence of other musculoskeletal disorders among farmers is indicated in some studies, although research is limited [64,130,211]. In paper I we demonstrated a higher lifetime prevalence rate and a higher one-year incidence rate of musculoskeletal symptoms among farmers than among occupationally active rural referents. The higher incidence rate was significant for symptoms from hands and forearms, low back and hips, and this corresponds well with previously reported findings. Knee osteoarthritis has also been studied with regard to farming, but the results are less conclusive, with risk numbers lower than for hip osteoarthritis [79,170,220]. In this study, farmers and referents reported knee symptoms and neck and shoulder symptoms to about the same extent.

Despite the higher prevalence and incidence rate of musculoskeletal symptoms, the farmers did not seek more health care for musculoskeletal problems than did the referents. In addition, it was shown that farmers had been sick-listed significantly less for low back and knee problems. There may be several reasons why farmers with symptoms do not seek medical advice to the same extent as referents with symptoms do. The distance to health care facilities is documented as a factor related to care-seeking frequency [92]. However, farmers and referents were sampled in such a way that the distances to health care did not differ between the groups. Swedish farmers are almost exclusively self-employed. It has been shown that self-employed people seek health care less often than salaried employees [5]. Responsibility for livestock, troublesome economic situations or merely different norms may be other factors related to low health care utilization rates among farmers. However, the fact that farmers seem to seek less health care than referents in relation to reported symptoms indicates that risk estimates based on registered consultations, hospital admissions or radiological findings might underestimate the farming-related risk.

After adjustment for the influence of physical work exposures, farmers still had an excess rate of low back pain and hip symptoms compared with the referents, and a contrasting significantly lower rate of neck and shoulder problems. Many studies have demonstrated an association between heavy lifting and working with awkward posture (twisting and bending) with low back pain [28,83,144]. Our results support these observations. However, in the present study, self-reported exposure to vibrations was not associated with low back pain, contrary to most findings [18,23,144].

General physical workload, in this study assessed using the Edholm activity scale, obviously incorporates other components than just heavy lifting, since workload and heavy lifting had different impacts on low back pain. In fact, higher physical workload was associated with a significantly decreased prevalence rate of low back pain. The workload variable includes all levels of work-related physical activity and permits great variation in the work tasks. An unexpected finding was the strong positive association between physical work capacity (oxygen uptake capacity as tested with the submaximal ergometer test) and low back pain. Physical capacity thus appears to be independent of physical workload. Physical capacity might be more related to personal factors and leisure activities. High leisure-time physical activity was associated with a lower rate of neck-shoulder pain among the referents, but not among the farmers. A similar but not significant pattern was seen for low back pain. The relationship was linked to the small group of vigorously active men and no association between leisure time activity and neck-shoulder pain or low back pain were seen for less active men.

Muscle strength tended to be correlated to low back pain in univariate analyses, but after adjustments muscle strength was associated only with hand and forearm symptoms, in a negative direction. In a 5-year follow-up study, Kujala and coworkers [105] concluded that muscle strength characteristics were not predictive of future back pain. We actually found a U-shaped relationship between total muscle strength and low back pain in that both low and very high total strength were associated with higher rates of low back pain as compared to the middle range. More studies with prospective designs are needed to analyze causality and the significance of muscle strength with respect to musculoskeletal disorders.

We have found no other studies comparing musculoskeletal outcomes among farmers with other occupational groups after multiple adjustments, and few comparable studies on other professions. Josephson et al. [97] studied nurses seeking health care for low back pain. Their results did not show any excess risk of low back pain among nurses as compared with controls in other occupations after physical and psychosocial factors were considered. In another study, sedentary workers (crane operators and straddle-carrier drivers) had an increased risk of low back pain compared with office workers after adjustment for age and confounders [27].

In paper III we demonstrated that the high rate of low back pain reported by the farmers as compared to the referents could not be attributed to psychosocial factors. However, the farmers' low rate of sick leave for low back pain might be associated with factors related to self-employment. Few authors have studied psychosocial factors in farming or among self-employed professionals. In a Swedish study with 3800 persons living in rural areas, Thelin [203] showed that farmers experienced significantly higher demands and higher authority (or control) over work as assessed according to Karasek and Theorell than other occupational groups. Our results are in line with these observations.

There is little research available on experienced health and morbidity among the self-employed and contractors. A longitudinal study showed that self-employment was associated with neck-shoulder symptoms but not with low back pain [12]. In a study of 180 patients with rheumatoid arthritis, Yelin et al. [224] showed that self-employed persons had a significantly lower risk of work-related disability in comparison with employees. In our study, including a considerably large proportion of self-employed non-farmers, self-employment tended to be associated with a low rate of low back pain, as did medical consultations and sick leave, even after multiple adjustments. Swedish farmers are almost exclusively self-employed and therefore direct adjustment for this variable could not be made. Farmers, like contractors, probably have other incentives than salaried employees have, and these circumstances and related norms and values could possibly have an impact, especially in relation to attitudes towards sick leave. Other type of studies including prospective design and perhaps qualitative approaches are needed to gain further insight into these relationships.

Antonovsky's sense of coherence (SOC) [7] is a concept that might be of relevance in this respect. Farmers tended to report a somewhat lower SOC than referents [78,184]. In a separate report we have demonstrated that SOC is related to psychosocial work factors, general living conditions and social support [78]. However, no explanatory effect of SOC was found when we tested the effects of SOC on the difference in musculoskeletal symptom reporting between farmers and referents (not shown in these papers).

In this study, work-related psychosocial factors were correlated to all the three low back pain outcomes (symptoms, consultations and sick leave) in predicted directions. The results are in accordance with other studies on psychosocial factors and low back pain [82] and sick leave [75,146,147]. However, social network as assessed with the index described was not related to any of the low back outcomes. The index does not cover co-worker and supervisor support, factors that have been related to low back pain in other studies of social networks [82,162,205,208], and this difference may be critical. Co-worker and supervisor support are, however, not relevant variables for measuring support among farmers and other self-employed individuals working alone as compared to the situation for salaried employees. Unexpectedly, marital status showed different effects among farmers and referents. Being single is usually associated with increased rates of low back pain and sick leave [112,113], but for the farmers in this study the opposite was found.

Educational level was not related to any of the low back pain outcomes in this fairly homogenous study population. Lifestyle factors were included in the analyses as potential confounders. Smoking was associated with a decreased risk of low back pain but did not influence medical consultations or sick leave. Current research is inconsistent about whether there is an association between smoking and low back pain, and causality is uncertain [109]. Overweight was consistently related to low back pain, medical consultations and sick leave. There is inconclusive evidence on the influence of anthropometric measures on low back pain [28]. Combined effects, direct or indirect effects of various lifestyle factors occurring simultaneously, might be at hand. The influence of overweight on musculoskeletal functioning, medical consultations and sick leave needs further attention [108].

The fact that the farmers' high prevalence of low back pain cannot be "explained" in terms of physical work exposure and psychosocial factors, indicates that although these factors are related to low back pain other etiological factors must be involved. Various comorbidities have been associated with low back pain, but causal mechanisms are unclear [77]. It is possible that linked diseases have a common origin in addition to the possibility of causal relationships. In paper IV we demonstrated that low back pain was associated with respiratory disease symptoms and with digestive disorders. Work-related fever attacks were related to low back pain in a way that indicated a dose-response relationship.

Farmers are frequently exposed to potentially immunologically active substances. Exposure to organic dust in farming has been associated with respiratory disorders [127,168], airway symptoms [47] and febrile reactions [128]. Work-related fever attacks, caused by exposure to mould, unspecific dust or endotoxins are much more common among farmers than among non-farmers [32]. Our results confirm this, with 12% of the farmers and less than 2% of the referents reporting work-related fever attacks. We found no other studies on the relationship between this type of work-related febrile reactions and musculoskeletal disorders. The association found in our study might support the idea of immunological mechanisms being involved in the development of musculoskeletal disorders. This is in line with the hypothesis proposed by Hurwitz and Morgenstern [89] concerning inflammatory effects from prior stressors resulting in depression and pain as independent outcomes. In a recent case-referent study on farmers diagnosed with hip osteoarthritis and matched farmers free from this disease, it was demonstrated that work in animal production (dairy or swine confinement) was significantly related to hip osteoarthritis [202]. This supports the idea of other etiological components besides physical workload being involved in the development of osteoarthritis.

Most studies on the relationship between low back pain and gastrointestinal symptoms and digestive disorders focus on medication side effects. Some studies, however, indicate a positive relationship between low back pain and digestive disorders such as irritable bowel syndrome [10]. An association between low back pain and digestive disorders might be logical if immunological mechanisms have an impact on the risk of musculoskeletal disorders such as low back pain and osteoarthritis.

The studies included in this thesis demonstrate that physical work exposures and psychosocial factors, today the most commonly discussed risk factors for musculoskeletal disorders, do not fully explain low back pain incidence differences between these two groups, although they differ considerably in their risk factor profile. Other etiological factors must be at hand, and one proposed aspect is inflammatory mechanisms, which may, one way or another, be a common origin for low back pain and its comorbidity.

Conclusion

In conclusion, we found that:

1. Farmers reported higher lifetime prevalence and higher one-year incidence of musculoskeletal symptoms than rural referents. The prevalence was significantly higher for low back pain, hip symptoms and symptoms from hands and forearms. When physical workload factors were adjusted for, it was revealed that farmers actually reported a lower prevalence of neck-shoulder symptoms than non-farmers.
2. Despite a high prevalence of musculoskeletal symptoms, farmers did not seek more health care in terms of medical consultations for musculoskeletal symptoms than the referents. In addition, farmers reported significantly fewer sick leaves for low back pain and knee problems than the referents.
3. Physical work exposures were related to musculoskeletal symptoms among farmers in the predicted direction. Heavy lifting and work in difficult positions were particularly strongly correlated with low back pain, while for general physical workload a protective effect was found. Physical work exposures could not fully "explain" the higher prevalence of low back and hip symptoms reported by the farmers.
4. Several of the psychosocial and lifestyle variables included in the study were associated with low back pain, medical consultations and sick leave. Nevertheless, psychosocial and lifestyle factors only marginally explained the farmer-referent difference in low back pain outcomes. Farmers and self-employed referents both reported low sick leave rates for low back pain, although farmers reported high and self-employed referents low prevalence of low back pain.
5. Significant associations between low back pain and digestive and respiratory disorders were revealed, indicating that these disease entities may have etiological factors in common.

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Swedish summary

Bakgrund och syfte

Lantbrukare har i jämförelse med andra yrkesgrupper en betydligt större risk att drabbas av höftledsartros. Orsakerna till detta är inte klarlagda men studier tyder på att hög grad av fysisk belastning i arbetet inte är tillräckligt som förklaring. Huruvida lantbrukare har mer av andra typer av besvär från rörelseapparaten jämfört med andra yrkesarbetande är inte klarlagt. Eftersom fysisk belastning tydligt har kunnat relateras till en högre förekomst av muskuloskelettala besvär finns skäl att tro att lantbrukare har mer sådana besvär.

Syftet med denna avhandling har varit att studera förekomsten av symptom och sjukdomar i rörelseorganen hos lantbrukare och att bedöma effekten av fysisk belastning och psykosociala faktorer. Avsikten var vidare att undersöka om fysisk arbetsbelastning, psykosociala faktorer eller livsstilsfaktorer kunde förklara skillnader i förekomst av muskuloskelettala besvär, sjukvårdskonsumtion och sjukskrivning mellan lantbrukare och kontroller. Slutligen avsågs att studera samband mellan ländryggsbesvär och annan sjuklighet.

Material och metod

Forskningsprojektet FAJ – Frisk av jobbet designades som en prospektiv kohortstudie med lantbrukare och landsbygdsboende kontroller i avsikt att studera salutogena faktorer i en population med låg sjuklighet och dödlighet. Avhandlingen baseras på tvärsnittsdata från den första undersökningsomgången. I lantbruksregistret identifierades alla manliga lantbrukare, födda 1930-49, i nio utvalda kommuner i Sverige. Efter att lantbruksaktivitet fastställts inkluderades 1221 lantbrukare i studien. Till dessa matchades kontroller från befolkningsregistret, totalt inkluderades 1130 kontroller. Samtliga lantbrukare och kontroller inbjöds till en omfattande hälsoundersökning innefattande enkäter, intervjuer, ett flertal tester och undersökningar. Deltagarfrekvensen var 76 %.

Resultat

Lantbrukarna rapporterade signifikant högre livstidsprevalens och högre ettårsincidens av ländryggsbesvär, höftbesvär, hand- och underarmsbesvär i jämförelse med kontrollerna. Trots en högre förekomst av besvär hade inte lantbrukarna sökt sjukvård för muskuloskelettala besvär i större utsträckning än kontrollerna hade gjort. Det var signifikant färre lantbrukare än kontroller som varit sjukskrivna för rygg- eller knäbesvär.

Fysisk arbetsbelastning var relaterat till muskuloskelettala besvär som förväntat. Tunga lyft och svåra arbetsställningar var starkt korrelerat till ländryggsbesvär medan hög generell fysisk arbetsbelastning snarast hade en skyddande effekt. Fysisk arbetsbelastning kunde inte ”förklara” den högre förekomsten av rygg- och höftbesvär hos lantbrukarna. Efter justering för fysisk arbetsbelastning visade det sig att lantbrukarna hade signifikant lägre förekomst av nack- och skulderbesvär i jämförelse med kontrollerna. Flera psykosociala faktorer var relaterade till ländryggsbesvär, sjukvårdskonsultation och sjukskrivning i förväntad riktning. Psykosociala faktorer kunde dock endast marginellt förklara skillnaden i ländryggsbesvär mellan lantbrukare och kontroller. Både lantbrukare och egenföretagande kontroller hade låg sjukskrivningsfrekvens på grund av ländryggsbesvär trots att lantbrukare rapporterade hög och egenföretagande kontroller rapporterade låg förekomst av ländryggsbesvär.

Ländryggsbesvär var signifikant vanligare hos personer med symptom från andningsorganen och från magtarmkanalen. De som haft flera sådana symptom hade dubbelt så stor sannolikhet att också rapportera ländryggsbesvär. Arbetsrelaterade feberattacker, som 12 % av lantbrukarna men mindre än 2 % av kontrollerna upplevt, var signifikant relaterat till ländryggsbesvär.

Konklusion

Mitt arbete visar att besvär från höfter och ländrygg är vanligare förekommande bland lantbrukare än bland andra yrkesaktiva. Delarbetena visar vidare att fysisk belastning och psykosociala faktorer, de idag vanligaste riskfaktorerna som diskuteras i relation till muskuloskelettala besvär, inte fullt ut kan förklara skillnaderna i förekomst av ländryggsbesvär mellan två grupper som skiljer sig betydligt i riskfaktorprofil. Andra etiologiska faktorer måste vara involverade och inflammatoriska mekanismer som också kan vara relaterade till den påvisade komorbiditeten är tänkbara.

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