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THE IMPACT OF PHYSICAL WORK EXPOSURE ON MUSCULOSKELETAL SYMPTOMS AMONG FARMERS AND RURAL NON-FARMERS. A POPULATION-BASED STUDY

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Abstract: In order to evaluate the impact of physical work exposure on differences in musculoskeletal symptom reported among Swedish farmers and referents, a cross-sectional, population-based cohort study was performed. Male farmers (N = 1221) and matched non-farmers (N = 1130) were invited to take part a survey in which 76% participated. The analyses were based on 657 matched pairs. Lifetime incidence of musculoskeletal symptoms, information on work exposure, physical workload and leisure time physical activity were assessed by questionnaire and structured interview. Physical work capacity and muscle strength were measured. Farmers reported more low back and hip problems than the referents. After adjustment for the influence of work exposure factors, farmers still had a significant excess rate of low back and hip symptoms compared to the referents, and a significantly lower rate of neck and shoulder problems. In conclusion, work exposure explained some but not all of the farmer-referent differences in musculoskeletal symptom rates.

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INTRODUCTION

In a number of studies, male farmers reported significantly more musculoskeletal symptoms than other occupationally active men in Sweden [9, 27, 29], Finland [21, 24] and other countries [19]. Recent reviews concluded that twisting, bending, manual material handling and exposure to whole-body vibrations were risk factors for low back pain [5, 10, 22]. However, the impact of heavy physical work in general on low back problems is still inconclusive. Moreover, high physical workload has been proposed as a contributing factor in the development of osteoarthritis of the hip [33] and the knee [26].

Neck and shoulder symptoms have also been related to working conditions, especially monotonous and repetitive work tasks [12, 23]. In addition, psychosocial factors seem to have a large impact on neck and shoulder problems, as well as on low back pain [1, 2, 3, 28].

In a previous study, we found that farmers reported significantly more hand and forearm problems, low back pain and hip problems than non-farmers, and tended to have more neck and shoulder and knee problems [9]. The purpose of the present study was to see how much of the differences in symptom reporting between farmers and non-farmers could be "explained" by differences in physical work conditions. The report is based on baseline

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data from a prospective study of health risks and health-promoting factors among Swedish farmers and referents matched for age, sex and residential area.

STUDY POPULATION

All male farmers born between 1930–1949 and living in nine rural Swedish municipalities across the country were identified in 1989 using the national farm register. Farmers were defined as persons who owned or rented a farm and spent at least 25 hours per week in farming. Farm labourers were thus not included. To ensure the occupational affiliation to farming, the local representatives in the local branches of the Federation of Swedish Farmers were consulted. Overall, 1,221 farmers fulfilled the sampling criteria.

A reference population was sampled from the national population register. The referents were matched to the farmers by age, sex and residential area and had to be occupationally active. An age mismatch of ±3 years was allowed. Since most Swedish municipalities consist of rural areas as well as urban dwellings, the smallest official administrative area (parish) was used to define residential area in order to ensure that the farmers and referents were living in the same area. After this procedure, 1,130 referents were sampled. Because the areas were rural, the number of potential reference subjects was limited and therefore the included referents were somewhat fewer than the farmers.

The 1,221 farmers and 1,130 referents were invited to take part in a baseline survey conducted by two co-trained teams of physicians and technicians during a 12-month period to allow for possible seasonal variation. 1,013 (83%) farmers and 769 (68%) referents participated. A detailed description of the sampling procedure, the survey, and an analysis of the reasons for and effects of non-participation has been given elsewhere [9, 27]. Briefly, there were no major differences between participants and non-participants. The responding study population formed 657 complete matched pairs. The characteristics of these 1,314 persons were similar to the characteristics of the 1,782 responding persons.

METHODS

Information on symptoms from the musculoskeletal system was assessed by a self-administered questionnaire. The outcome measures for this report were the answers to the following questions: 1) “Have you ever and not only occasionally had problems in the neck, shoulder or shoulder joint areas with ache, pain or discomfort?” 2) “Have you ever had problems with numbness or a pricking sensation in your hands?” 3) “Have you ever had problems in the low back area with ache, pain or discomfort?” 4) “Have you at any time had problems in the hip area with ache, pain or discomfort?” 5) “Have you ever had problems in one or both of your knees with ache, pain or discomfort?”. Possible responses to each question were “yes” or “no”.

Table 1. Prevalence rates of outcome and exposure variables among farmers and referents.

	Farmers	Referents	p
Number, n	657	657	
Outcome			
Neck and shoulder symptoms, %	53.3	54.1	0.759
Hand and forearm symptoms, %	34.1	30.1	0.124
Low back pain, %	67.7	57.7	<0.0001
Hip symptoms, %	31.7	21.6	<0.0001
Knee symptoms, %	45.6	43.4	0.470
Exposure			
Workload, units	234.3	140.5	<0.0001
Vibrations, %	74.0	34.4	<0.0001
Heavy lifting, %	86.5	41.9	<0.0001
Difficult working positions, %	75.3	42.8	<0.0001
Work hours	10.2	8.4	<0.0001
Sleep hours	7.1	6.9	0.0003
Years in current job	25.1	19.5	<0.0001
No vacation last year, %	63.8	8.7	<0.0001
Leisure-time activity, mean score	1.7	2.1	<0.0001
Sedentary, %	40.6	15.2	
Slightly active, %	48.8	67.0	
Moderately active, %	8.3	14.6	
Vigorously active, %	2.3	3.2	
Muscle strength, total, units	2171.3	2151.3	0.353
Hand, units	615.8	609.3	0.278
Arm, units	424.9	408.6	0.003
Thigh, units	604.3	609.8	0.499
Physical capacity, l/min	3.0	2.7	<0.0001

Data on the number of working hours and hours of sleep, on physical workload and leisure time physical activity was obtained by a standardized interview. Physical workload was assessed as the reported 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 [11]. Because of the large seasonal variation, the farmers were asked to estimate the average workload over the year. Physical activity during leisure time was assessed as sedentary, slightly active, moderately active and vigorously active [25].

Information on exposure to vibrations, heavy lifting and difficult working positions in the current job was obtained by questionnaire, as was information on the number of years in the current occupation and on vacation during the last year. The latter was classified as full (4 weeks or more), partial, or no or only a few days off. The farmers were also asked if they had partners, hired staff, or if they used substitutes. Physical work capacity was determined using a submaximal work test on a bicycle

Table 2. Crude odds ratios (OR) for the lifetime incidence of musculoskeletal symptoms with 95% confidence intervals (95%CI).

	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	0.98	0.78-1.20	1.20	0.95-1.51	1.54	1.23-1.93	1.69	1.32-2.17	1.08	0.87-1.35
Workload per 100 units	1.05	0.93-1.19	1.23	1.08-1.41	1.11	0.98-1.27	1.19	1.03-1.37	1.10	0.97-1.25
Vibrations	1.40	1.12-1.75	1.98	1.55-2.53	1.40	1.12-1.76	1.75	1.35-2.26	1.54	1.23-1.93
Heavy lifting	1.47	1.17-1.85	1.71	1.33-2.21	1.85	1.46-2.35	1.53	1.16-2.00	1.51	1.20-1.91
Difficult working positions	1.69	1.35-2.12	2.00	1.56-2.57	1.94	1.53-2.44	1.67	1.28-2.17	1.53	1.21-1.91
Work hours	0.99	0.95-1.04	0.98	0.94-1.03	1.02	0.98-1.07	1.01	0.96-1.07	1.01	0.96-1.05
Sleep hours	0.90	0.79-1.01	0.89	0.78-1.02	1.03	0.90-1.17	1.02	0.89-1.18	0.91	0.81-1.04
Time in current job per 10 years	1.06	0.96-1.16	1.01	0.91-1.12	1.15	1.04-1.27	1.06	0.95-1.18	1.09	0.99-1.20
Self-employment	1.01	0.81-1.26	1.13	0.89-1.43	1.27	1.01-1.60	1.55	1.20-2.00	0.91	0.73-1.13
No vacation	1.06	0.84-1.33	1.22	0.96-1.56	1.17	0.92-1.48	1.57	1.22-2.03	1.08	0.86-1.36
Leisure activity	0.96	0.82-1.12	0.96	0.82-1.14	0.81	0.69-0.95	0.88	0.73-1.05	1.04	0.89-1.22
Body mass index per 5 kg/m^2	1.13	0.96-1.34	1.18	0.99-1.41	1.11	0.93-1.32	1.10	0.92-1.33	1.10	0.93-1.31
Total muscle strength per 100 units	0.99	0.96-1.03	0.97	0.94-1.00	1.03	1.00-1.07	0.99	0.96-1.03	1.00	0.97-1.03
Physical capacity	1.01	0.84-1.21	1.06	0.87-1.29	1.45	1.20-1.77	1.16	0.95-1.43	1.05	0.88-1.26
Smoking	1.08	0.84-1.39	1.00	0.76-1.30	0.78	0.60-1.01	0.78	0.57-1.03	0.81	0.63-1.05

ergometer [36]. Muscle strength was measured in the hand, arm and thigh [32]. The various measures for hand, arm and thigh were summarized to a total score.

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 (kilograms) divided by height (meters) squared. Smoking habits were assessed in a structured interview. For the present report, smoking habits were dichotomized into current daily smoking versus no smoking.

STATISTICAL ANALYSIS

The statistical analyses were performed with the SPSS, SAS and JMP software. The partial non-response rate (missing values in data from responders) was less than 1% except for arm muscle strength, where 8.6% of the data were missing due to technical problems with the equipment. Due to disability or clinical precautions, 87 persons (6.6%) did not perform the submaximal work test.

The analyses were performed conditionally, keeping the matched pairs together. 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% confidence intervals (95%CI) in univariate as well as multiple analyses. Backward elimination of non-significant exposure variables was used until all remaining variables were significantly related to the outcome except for farmer status, which was kept in the model irrespective of significance level. Before being entered in the regression analysis, workload units and muscle strength units were divided by 100, years in current job were divided by 10, and BMI by 5.

Leisure time activity showed different trends between farmers and referents. An interaction term included in the analysis was significant. Therefore, the effects of leisure time activity were presented separately for farmers and referents. All tests were two-tailed. A p-value of 0.05 was regarded as statistically significant. Very small p-values are given as <0.0001, even when they were much smaller.

RESULTS

Characteristics of the study population. Farmers and non-farmers were of equal average age (50 years) and had similar body mass index, 26.3 kg/m^2 versus 26.6 kg/m^2. Smoking was less common among the farmers than among the referents (18.9% *vs.* 30.6%, $p < 0.0001$). Farmers were self-employed to a much larger extent than the referents (92.5% *vs.* 18.7%, $p < 0.0001$). Some of the farmers had part-time jobs in other businesses and were therefore also employed. Of those employed in the complete sample, about half were in public service and half in private companies. The mean farm size was 56 hectares, approximately 112 acres. The main types of production among the farmers were dairy production (44.1%), crop growing (22.6%), pig farming (12.3%), cattle raising (12.2%) and other types (8.8%).

Reported outcomes and exposures. Farmers reported more musculoskeletal symptoms than non-farmers (Tab. 1). The differences were significant for low back and hip symptoms. The farmers reported significantly more workload, more vibrations, more heavy lifting, more difficult working positions, longer work and sleep hours, more years in the current job, but less vacation time and

Table 3. Adjusted 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. 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 years					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.

less leisure-time physical activity than the referents. They also had significantly higher total muscle strength and arm strength, and had a significantly higher physical work capacity as measured with the submaximal work test.

Univariate analyses. Workload, vibrations, heavy lifting and difficult working positions were correlated to all musculoskeletal symptoms (Tab. 2). Time in current job, self-employment, no vacation last year, total muscle strength and physical capacity were correlated to low back pain or hip problems. Work hours, sleep hours, leisure-time activity, body mass index and smoking were not correlated to any symptoms. Among the farmers, farm size and type of farm production, presence of partners, hired staff or substitutes had no influence on the reporting, except for knee symptoms, where the presence of substitutes was positively correlated to symptom reporting.

Multiple analyses. Since a number of factors were correlated to each of the outcome measures, a set of multiple analyses was performed. The results are shown in Table 3. For neck and shoulder problems, difficult working positions were associated with increased symptom reporting and leisure-time activity was associated with decreased reporting among the referents but not among the farmers. When the influence of these factors was taken into account, the farmers reported less neck and shoulder problems than the non-farmers (OR 0.62, 95%CI 0.47-0.82, p = 0.0008).

For hand and forearm symptoms, workload, vibrations, difficult working positions and BMI were all associated with increased reporting, while work and sleep hours and muscle strength were associated with decreased reporting. When the influence of these factors was taken into account, there was no longer any significant farmer-nonfarmer difference in hand and forearm symptoms.

For low back problems, heavy lifting, difficult working positions, work hours, time in the current job and physical capacity were all associated with increased reporting, whereas workload and self-employment were associated with decreased reporting. When the influence of these factors was taken into account, farmers reported symptoms 51% more often than non-farmers (OR 1.51, 95%CI 1.02-2.23, p = 0.038).

For hip symptoms, only vibrations were associated with increased reporting. When this was taken into account, the odds ratio for farmer status remained significant (OR 1.46, 95%CI 1.11-1.93, p = 0.007).

For knee symptoms, vibrations, heavy lifting and time in current job were associated with increased reporting, whereas self-employment was associated with decreased reporting. When the influence of these factors was taken into account, there was no clear difference in reporting of knee symptoms between farmers and non-farmers.

DISCUSSION

The high prevalence rates of low back and hip symptoms among farmers compared to referents could not be explained by physical work exposures. Farmers had a lower rate of neck and shoulder symptoms compared to the referents when physical work exposures were considered.

The study was designed to minimize the effects of traditional confounding factors such as sex, age and place

of residence, i.e. the urban-rural health gradient, observer bias (by co-training), seasonal variation (by scheduling examinations over the year) and recall bias (by using lifetime prevalence data) [27]. The non-response rate was somewhat higher among non-farmers but the reasons for non-response were the same in the two groups and there were no age differences between responders and non-responders. All information was collected on prepared forms, and validated questionnaires and measurement methods were used. We therefore have no reason to believe that the data should be biased to such an extent that the results would be affected. The farmers included in the study were considered representative of Swedish farmers [9, 27].

Several authors have discussed the problem of recall bias [6, 15]. Structured interviews are preferable to self-administered questionnaires for obtaining reliable information on physical workload [31]. In this study, questionnaires and structured interviews were combined. Persons with pain symptoms might estimate their physical work exposure differently than persons with no pain. However, Wiktorin *et al.* studied the inter-method reliability between self-administered questionnaires and interview data on physical load at work and during leisure time [35]. They found that subjects seeking care for low back or neck and shoulder disorders estimated workloads equally correctly or not as subjects not seeking care.

In this report, lifetime incidence of symptoms was used as the outcome. In a previous report, lifetime symptoms as well as symptoms during the last year were used [9]. The results with these two outcomes were similar but lifetime incidence had a better statistical power and was therefore used for this report. In an another study, we obtained data on hospital admissions from the National Hospital Admission Register and compared them with the corresponding self-reported data. The incidence rate ratio of hospital admissions among farmers versus non-farmers was the same as that found for recall data [27]. The recall bias regarding exposure and outcome variables therefore probably affects the results in both groups equally.

In several studies, farmers had a higher prevalence rate of musculoskeletal symptoms than other occupationally active men [8, 9, 18, 20, 21, 27, 30], mainly hand and forehand, low back and hip symptoms. In a meta-analysis, farmers did not have an excess risk for neck and shoulder problems [7]. Several studies have shown that heavy lifting and working in difficult working positions (e.g. twisting and bending) are risk factors for low back problems [5, 10, 22]. Our results support these observations. However, in the present study, self-reported exposure to vibrations was not associated with back pain, contrary to most studies [22].

We have found few other studies comparing musculoskeletal outcomes in different occupational groups after multiple adjustments [4, 13] and no studies of this kind involving farmers. Josephson *et al.* studied the risk of nursing staff seeking health care for low back pain. Their results showed that after adjustment for physical and psychosocial factors no excess risk for nurses compared to other occupations was seen [13]. In a cross-sectional study, sedentary workers (crane operators and straddle-carrier drivers) had an increased risk of low back pain compared to office workers after adjustment for age and confounders [4].

General physical workload, here assessed with the Edholm activity scale, obviously incorporates other components than just heavy lifting since workload and heavy lifting had different impacts on low back pain. The workload variable includes all levels of work-related physical activity and permits a great variation in the work tasks [11]. High physical work capacity was associated with a high rate of low back symptoms, whereas high workload rather had a “protective” effect. Physical work capacity thus appears to be independent of physical workload. Physical capacity might be more related to personal factors and leisure activities. A recent Swedish review concludes that no study so far has presented any strong evidence for an association between leisure activity or physical capacity and the risk of future back pain [22].

Sleep hours were significantly negatively associated with symptoms from hand and forearm. This observation may be a secondary effect of the symptoms and not an independent factor, since this type of symptom often results in sleep disturbance [17]. Follow-up studies are needed to evaluate causality concerning the studied relationships. Obesity, measured as increased body mass index, has been associated with carpal tunnel syndrome [16, 34]. Our data indicate that this relationship also applies to middle-aged men after adjusting for workload factors.

Muscle strength tended to be positively correlated to low back pain in the univariate analysis. However, after adjustment, the muscle strength variable was only correlated to hand and forearm symptoms in a negative direction. In a 5-year follow-up study, Kujala and co-workers [14] concluded that muscle strength characteristics were not predictive of future back pain. More studies with a prospective design are needed to analyze causality and the significance of muscle strength with respect to musculoskeletal symptoms. Higher physical capacity as measured with the submaximal work test was independently correlated to low back pain, a surprising result that warrants further investigation.

Leisure-time activity had a protective effect among the referents but no significant effect among the farmers. The effects were linked to the small group of vigorously active men. There was no relationship between leisure-time activity and symptoms among less active men, whether farmers or referents. Another problematic factor was self-employment status. This is closely linked with farmer status but has an effect opposite to farmer status regarding symptom reporting. Therefore, self-employment was in univariate analyses associated with more symptoms, but in multiple analyses with fewer symptoms since the effects in this instance were adjusted for the farmer status.

In conclusion, farmers had more low back pain and more hip problems than referents, even when the

influence of physical work exposures was taken into account. Therefore, preventive strategies focusing on physical workload factors might need to be supplemented by a broader approach. For example, psycho-socio-economic factors, lifestyle factors and comorbidity might be of interest for enhancing further understanding of musculoskeletal disorders among farmers.

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