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Ischaemic heart disease among livestock and agricultural workers

B Sjögren, J Weiner, K Larsson

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Correspondence to:
Dr B Sjögren, Work Environment Toxicology, Institute of Environmental Medicine, Karolinska Institutet, Box 210, SE-171 77 Stockholm, Sweden; Bengt.Sjogren@imm.ki.se

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Background: Agricultural workers are exposed to organic dust containing endotoxins, mites, and moulds.

Aims: To compare the occurrence of ischaemic heart disease (IHD) among male and female livestock and agricultural workers with gainfully employed men and women in Sweden.

Methods: Male and female livestock and agricultural workers were identified in the Swedish National Censuses of 1970 and 1990 and were followed until the end of 1995. The IHD mortality among the livestock and agricultural workers was compared with that of gainfully employed men and women. Information of smoking habits was gathered from a previous national survey.

Results: Male as well as female livestock workers had slightly higher standardised mortality ratios (SMR) regarding IHD compared with all gainfully employed men and women in Sweden. The SMR for male workers was 1.06 (95% CI 0.95 to 1.18). The SMR for female workers was 1.10 (95% CI 0.98 to 1.23). Agricultural workers had lower SMRs. Adjustments for smoking habits would further increase the SMRs by about 9% in male workers and about 5% in female workers.

Conclusion: The present data suggest a slightly increased risk for IHD among both male and female livestock workers, which may be the result of organic dust exposure.

A general hypothesis has linked inhalation of particles to the occurrence of ischaemic heart disease (IHD) via an inflammatory process with increased plasma concentrations of fibrinogen.^{1,2} Agricultural workers and farmers are exposed to organic dust containing endotoxins and other microbial agents, such as mites, and moulds, which may cause allergic and inflammatory respiratory diseases such as asthma, chronic bronchitis, and allergic alveolitis.³ Farmers in general, and swine farmers in particular, reported higher prevalence of respiratory symptoms than the non-farming population; continuous exposure in the farming environment may lead to airway obstruction.⁴ Chronic bronchitis has been reported to be more frequent in swine producing farmers than in grain farmers.⁵ Healthy, non-smoking, symptom-free swine farmers with no history of respiratory disease had an ongoing airway inflammation dominated by neutrophils assessed by bronchoalveolar lavage,⁶ and in healthy, asymptomatic, dairy farmers a subclinical airway inflammation with a cellular pattern dominated by lymphocytes was observed.^{7,8} A few hours of exposure in a swine confinement facility induces an intense airway inflammatory reaction with a cellular response dominated by neutrophils in healthy subjects,⁹ and may cause systemic reactions with fever, fatigue, and muscle pain, and increased leucocytes, acute phase proteins,⁹ and cytokines (interleukin 6, TNF α) in peripheral blood.¹⁰ Exposure in a swine confinement house induced a more than 50% increase

of fibrinogen in plasma in healthy volunteers.¹¹ During the past decade high plasma levels of fibrinogen have become an established risk factor for IHD.¹²

Most cohort studies of farmers have observed a reduced risk for ischaemic heart disease^{13,14} when farmers are compared with a total national population. When death rates of farmers or other gainfully employed persons are compared with the total population, there is often an underestimation of the true risk as the general population includes sick and disabled people unable to work. This underestimation is well known as the healthy worker effect.¹⁵ However, a Swedish case-referent study¹⁶ showed an increased risk of myocardial infarction among farm managers and supervisors. The purpose of this study was to investigate whether livestock and agricultural workers had an increased risk of IHD.

MATERIAL AND METHODS

Livestock and agricultural workers were identified as two separate occupational groups in the National Census of 1970. These workers were followed from 1970 until 31 December 1995. In the later census of 1990, these two groups of workers were merged into one, which was followed until the end of 1995. The livestock and agricultural workers were identified with their 10 digit identification number, and the established cohorts were linked to the Cause of Death Register during the period of follow up. The referent groups comprised all gainfully employed men and women identified in the respective census. The total numbers of male and female referents in the 1970 census were 2 047 861 and 1 260 583, respectively. The total numbers of male and female referents in the 1990 census were 2 163 967 and 2 020 548, respectively. The age of livestock and agricultural workers as well as referents was 20–64 years at the time of entry.

Main message

- Livestock workers may have an increased risk for ischaemic heart disease as a result of organic dust exposure.

Policy implication

- Reduction of air pollutants among farmers may decrease the risk for ischaemic heart disease.

Abbreviations: IHD, ischaemic heart disease; SMR, standardised mortality ratio

Table 1 Standardised mortality ratios (SMR) of IHD in different cohorts of male workers followed until the end of 1995

Cohort	Observed	Expected	SMR	95% CI
3015 male livestock workers in 1970 census	353	332.8	1.06	0.95 to 1.18
22663 male agricultural workers in 1970 census	2122	2113.6	1.00	0.96 to 1.05
8218 male agricultural and livestock workers in 1990 census	27	22.5	1.20	0.79 to 1.75

Table 2 Standardised mortality ratios (SMR) of IHD in different cohort of female workers followed until the end of 1995

Cohort	Observed	Expected	SMR	95% CI
6242 female livestock workers in 1970 census	305	278.0	1.10	0.98 to 1.23
36080 female agricultural workers in 1970 census	1791	1820.7	0.98	0.94 to 1.03
3153 female agricultural and livestock workers in 1990 census	4	1.5	2.64	0.72 to 6.77

Ischaemic heart disease (IHD) was defined as code 410–414 of the International Classification of Diseases, 7th and 8th revisions (ICD 7 and 8).

Data analyses

The expected number of deaths in each age stratum was calculated by multiplying the death rate (number of deaths/number of person-years) of all gainfully employed in the age stratum with the number of person-years among livestock and agricultural workers in the same age stratum. The total number of expected deaths is the sum of expected deaths in all age strata. Standardised mortality ratio (SMR) was calculated as the ratio between observed and expected numbers of deaths. The 95% confidence limits were calculated with an approximative method.¹⁷

Smoking is strongly associated with IHD and the risk ratio in male and female smokers was assumed to be doubled compared with non-smokers.¹⁸ Smoking habits were surveyed in the total Swedish population aged 18–69 years in 1963.¹⁹ The total sample comprised 25 450 men and 26 469 women. In the general male population 49% were current daily smokers, whereas 34% of workers within agriculture, forestry, and fishing were smokers. In the general female population 19% were current daily smokers compared with 13% of female workers within agriculture, forestry, and fishing.¹⁹ To estimate the differences in risk of IHD due to smoking habits among livestock and agricultural workers compared with the general population, expected incidences were calculated as proposed by Axelson and Steenland.²⁰

RESULTS

The mortality due to IHD in male and female livestock workers tended to be higher than expected (table 1 and 2). The merged groups of livestock and agricultural workers in 1990 census were smaller than the cohorts of the 1970 census. However, the highest SMRs were found in the cohort of the 1990 census.

The impact of smoking on IHD was estimated as follows²⁰:

$$I_{mg} = I_o \times 0.51 + RR_s \times I_o \times 0.49$$

$$I_{law} = I_o \times 0.66 + RR_s \times I_o \times 0.34$$

I_{mg} is the incidence rate for men in the general population regarding IHD. I_{law} is the incidence for male livestock and agricultural workers and I_o is the incidence for non-smoking men. RR_s is the risk ratio for IHD when comparing smokers and

non-smokers using this model. The estimated relative risk (I_{law}/I_{mg}) for IHD was 0.91 when male livestock and agricultural workers were compared with the general population. The corresponding relative risk was 0.95 when female workers were compared with the general female population.

DISCUSSION

In the present study all groups, including livestock workers, had SMRs above 1. In previous cohort mortality studies of farmers the reference mortality incidence has been based on national rates. Most cohort studies of farmers or agricultural workers have shown a reduced risk for ischaemic heart disease.^{13–14} As mentioned before this reduction might be explained by a biased comparison with a general population comprising sick and disabled persons.¹⁵ However, a Swedish case-referent study¹⁶ observed an increased risk of myocardial infarction among farm managers and supervisors after adjustment for age, county, and socioeconomic group. Female farmers in Finland had a higher risk regarding coronary deaths.²¹ In Norway the general male mortality related to IHD decreased in the period 1971–75 compared with the period 1981–85. However, in agricultural communities mortality increased in most age groups except among the oldest (>75 years).²²

Smoking is strongly associated with IHD and the risk ratio in male smokers is doubled compared with non-smokers.¹⁸ If the crude correction described previously is applied, the smoking adjusted SMR regarding IHD among livestock and agricultural workers should be about 9% higher in men and about 5% higher in women. Thus, our calculated SMRs are most likely underestimations of the true risk. However, these adjustments may not be valid for the cohort of 1990 as the survey of smoking habits was performed in 1963.

High serum cholesterol is an important risk factor for IHD. In a cross sectional study 1013 farmers were compared with 769 non-farming rural men in Sweden. The fat intake was reported to be higher among farmers, and the mean total cholesterol level was the same in the two groups. However, high density lipoprotein and physical work capacity were higher and diastolic blood pressure and waist/hip ratio were lower among the farmers. Thus, farmers had a more favourable distribution of several risk indicators of IHD.²³ It could be assumed that farm workers are more similar to farmers than to non-farming rural men in our country.

There is convincing evidence that exposure to the farming environment causes airway inflammation and systemic effects. Thus, acute exposure while weighing pigs in a confinement building induced a doubling of the leucocyte

number and a fourfold increase in C reactive protein in peripheral blood.⁹ Three or four hours of exposure in a swine confinement house induced a four- to sevenfold increase of interleukin 6 and a more than 50% increase of fibrinogen in plasma in healthy volunteers,¹¹ and a modest increase of interleukin 6 among farmers.²⁴ Interleukin 6 stimulates hepatocytes to produce fibrinogen,²⁵ and it could be anticipated that farmers who are repeatedly exposed to the farming environment have increased levels of circulating fibrinogen. High plasma levels of fibrinogen is an established risk factor for coronary heart disease,¹² and there are data suggesting increased plasma fibrinogen levels and increased mortality due to coronary death in Finnish female farmers.²¹ A general hypothesis has linked inhalation of particles to the occurrence of IHD. Thus, inhalation of air pollutants retained in the lungs will hypothetically create a low intense airway inflammation associated with an increase in plasma fibrinogen. The high concentration of fibrinogen will increase the likelihood for blood clotting and thereby the risk for myocardial infarction and IHD.^{1,2}

An association has been reported between chronic bronchitis and myocardial infarction after adjustment for age, gender, smoking, diabetes mellitus, systolic blood pressure, angina pectoris, and total cholesterol.²⁶ Chronic bronchitis was also associated with IHD among men and women after adjustment for smoking, systolic blood pressure, and cholesterol.²⁷ Furthermore, chronic non-productive cough was associated with increased plasma levels of fibrinogen.²⁶ One third to one half of the swine farmers have reported respiratory symptoms such as cough, phlegm, and shortness of breath.^{28,29} Canadian swine producing farmers also had significantly more symptoms of chronic bronchitis than did grain farmers.⁵ The dominating clinical picture in farmers is thus chronic bronchitis, but an increased prevalence of asthma has also been reported.³⁰ Airflow obstruction seems to be more frequently observed in farmers than in the non-farming population,³¹ and in a study by Iversen *et al* it was shown that farmers with no airway symptoms had normal lung function, whereas farmers who experienced airway symptoms had an impaired lung function.³² Several indices of airflow were slightly but significantly impaired in swine producing farmers compared with grain farmers.³ In a group of 62 pig farmers a correlation was found between endotoxin exposure and lower FEV₁.²⁹ A low FEV₁ is a risk factor for IHD after adjustment for age, smoking, diastolic blood pressure, cholesterol, BMI, and social class.³³ A relation between impaired lung function (FEV₁) and increased concentrations of fibrinogen has been shown in Swedish men³⁴ and Danish men and women.³⁵ Thus it seems as if swine producing farmers have more respiratory symptoms (cough) and airflow limitation compared with grain farmers and other populations. These conditions are associated with an increased occurrence of IHD.

During the follow up period individuals in the different cohorts may leave exposed work because of retirement or other reasons. The longer the period of follow up the larger the proportion of individuals not exposed. The census data did not allow us to control for this, but there was a large decrease in the number of individuals employed in the agricultural sector during the observation period. Thus a substantial number of individuals left this sector. The increase in mortality is greater in the 1990 cohort than in the 1970 cohort. Inhalation of organic dust might be analogous to smoking as ex-smokers are known to have a lower IHD mortality compared with current smokers.¹⁸ If current agricultural work is associated with increased risk this may be explained by the fact that a larger proportion is exposed during the whole period of follow up in the 1990 cohort compared to the 1970 cohort. Further studies are needed in order to investigate the relation between current livestock and agricultural workers and ex-workers in relation to IHD morbidity and mortality. In these studies better estimates of occupational exposure factors as well as confounders are strongly needed.

In conclusion, the present data suggest a slightly increased risk for IHD among both male and female livestock workers, which may be the result of organic dust exposure.

Authors' affiliations

B Sjögren, Work Environment Toxicology, Institute of Environmental Medicine, Karolinska Institutet, Box 210, SE-171 77 Stockholm, Sweden
J Weiner, Swedish Work Environment Authority, SE-171 84 Solna, Sweden
K Larsson, Lung and Allergy Research, Institute of Environmental Medicine, Karolinska Institutet, Box 210, SE-171 77 Stockholm, Sweden

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