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A Cross-Sectional Study of Farmer Health and Wellbeing in Norway: The HUNT Study (2017-2019)

Natalie A. Steen[a], Steinar Krokstad[b,c], and Magnhild Oust Torske[a]

[a]Faculty of Biosciences and Aquaculture, Nord University, Steinkjer, Norway; [b]HUNT Research Centre, Department of Public Health and Nursing, Faculty of Medicine and Health Sciences, NTNU, Levanger, Norway; [c]Levanger Hospital, Nord-Trøndelag Hospital Trust, Levanger, Norway

ABSTRACT

Objectives: Obtain a broad impression of the health and wellbeing of working farmers in a representative population.

Methods: A cross-sectional study using data from a large, general population-based survey, The HUNT Study, Norway (HUNT survey 4, 2017–2019, response rate 54%). The study included 24,313 occupationally active participants aged 19 to 76 years, including 1,188 farmers. Prevalences are estimated for outcomes covering musculoskeletal, respiratory, and mental health as well as general health and life satisfaction, with adjustment for worker age and sex. The estimates for farmers are compared to skilled white collar workers and skilled manual workers.

Results: Farmers had a higher estimated prevalence of poor overall health (prevalence ratio [PR] 1.56 [95%CI 1.34,1.82]), chronically impaired mobility (PR 1.83 [1.53, 2.20]), long-standing musculoskeletal pain or stiffness (PR 1.29 [1.21, 1.37]), work-related respiratory attack (PR 4.32 [3.67, 5.08]), depression symptoms (PR 1.30 [1.04, 1.61]) and symptoms of psychological distress (PR 1.23 [1.04, 1.47]) than skilled white collar workers. The estimated prevalence of poor overall health (PR 1.19 [1.00, 1.41]) and work-related respiratory attacks (PR 1.44 [1.24, 1.67]) was also higher for farmers than skilled manual workers, after adjustment for age and sex. Farmers had greater odds of rating themselves less satisfied with life in general than skilled white collar workers (adjusted OR 1.17 [1.04, 1.31]).

Conclusions: These results are consistent with previous research and add evidence that farm work is associated with high prevalences of a broad range of adverse health outcomes. The associations with chronically impaired mobility, long-standing musculoskeletal pain, and poor self-rated health were strong. The adjusted PRs for work-related respiratory attacks relative to both comparison groups were particularly high. More research is needed to identify and evaluate interventions that can improve farmer health.

KEYWORDS

Occupational health; respiratory health; musculoskeletal pain; mental health; farmer

Introduction

The health and wellbeing of farmers is one aspect of the sustainability of farming. It exists in a complex inter-relationship between occupational health, food safety and security and the ecological and socioeconomic aspects of agriculture, with the latter being impacted by the transformation of modern agri-food systems.[1–3] The 2015 Eurofound report on working conditions in the EU and EEA countries concluded that skilled agricultural work should be classed as poor quality work, in large part due to poor health outcomes and declining autonomy.[4]

Research suggests farmers are at increased risk of several specific diseases and conditions that may be work-related, including conditions involving the musculoskeletal system (e.g., hip osteoarthritis and lower back pain[5,6], the respiratory system (e.g., non-atopic asthma, chronic bronchitis, and chronic obstructive pulmonary disease[7–9], and mental health conditions, including depression.[10–12] Additionally, farmers may be at increased risk of reduced quality of life in older age.[13] However, the evidence is mixed on the magnitude of associations between farming and poor health and wellbeing. This may reflect the fact that these associations are complex and may be somewhat context specific and not covered by a single research tradition.

Assessing causation in the relationship between occupational exposure and disease is complex. However, it has been suggested that working conditions and/or unique stress factors related to working as a farmer may play a causative role in

CONTACT Natalie A. Steen natalie.steen@nord.no Faculty of Biosciences and Aquaculture, Nord University, Steinkjer, Norway
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increasing the risk of chronic and/or cumulative musculoskeletal, respiratory, and mental health conditions.[6,14–17] These possible risk factors include long working hours, physically demanding work in changing and unpredictable conditions, working alone, working after typical retirement age, regulatory uncertainty, financial concerns, and social isolation.[10,17–20] A farmer's exposure to physical hazards depends upon the type of farming enterprise, but can involve exposure to heavy vehicles, fuel fumes, large animals, irritant chemicals, and organic dust and endotoxins.[16,21]

Chronic illnesses impact life quality and work performance[22] and, particularly when combined with perceived lack of autonomy, may lead to a need for disability pension and leaving the workforce prematurely.[23] Poor health is cited as one possible cause behind the increasing number of farmers exiting farming.[24]

This paper explores the health and wellbeing of the farmers of a region of Norway. We suggest the working conditions for these farmers were comparable to those in the rest of the country and in other high-income countries with diverse, seasonal crop and animal production.

The Trøndelag region of Norway is important to agriculture in Norway, responsible for approximately 20% of animal-based production and 12% of crop/vegetable production nationally in 2017, with dairy farming the main agricultural activity in the region in terms of person-hours.[25] The ownership, use, and subdivision of agricultural land in Norway has been strictly controlled for centuries and has resulted in the majority of farms being small to medium-sized, ancestral, owner-occupier enterprises, although co-operative models and land rental is increasing.[26–28]

Universal health services are available to all residents of Norway, with relatively small out-of-pocket fees and an annual spending ceiling, and all workers have statutory labor rights including sick, parental, and compassionate leave. However, for farmers, whose work often requires specific expertise and experience to carry out time-inflexible tasks in non-urban areas, these theoretical entitlements may not always be accessible in practice. Similarly, despite health and safety at work legislation existing in Norway, farmers are not as protected as other groups and are exposed to similar physical and psychosocial hazards experienced by farmers in other high-income countries. Nationally, farming has amongst the highest rates of occupational accidents per capita, particularly falls, being crushed, or being struck by objects,[29] and is the occupation with the highest rate of workplace fatality on a per worker basis.[30]

In this paper, we perform a cross-sectional analysis of associations between working as a farmer and a broad range of health outcomes with the aim to obtain a general impression of the health and wellbeing of farmers both in Norway and in comparable contexts. Health outcomes include overall self-rated health, musculoskeletal impairment and pain, respiratory attacks (cough, expectoration, wheeze or dyspnea) associated with work, poor life satisfaction and symptoms of depression, anxiety and/or psychological distress, using data obtained from a large population survey. Comparisons are made to two other groups of workers in the same population who also participated in the survey, and adjustment is kept to a minimum.

Methods

The main source of data for this paper was survey four of The Trøndelag Health Study (HUNT 4), the most recently available data from The HUNT Study. Data collection occurred during the years 2017–2019, and was completed before the COVID-19 pandemic arrived in Norway. All individuals who were ordinarily resident in North Trøndelag (North and South Trøndelag merged in 2017), as determined by the compulsory national register and were turning 20 years old or more that year, were invited to participate either by a physical letter, email, or text message. The survey involved a common baseline questionnaire, second baseline questionnaires (included some common items and some gender or age specific items), and targeted questionnaires. The questionnaires were completed online, on paper, or digitally at field stations. Additionally, interviews, the recording of some physical measurements, and the collection of biological samples were performed at home visits or HUNT field stations. Approximately 54% of those invited

participated in at least one of the components of HUNT 4.

Several NCD-RisC studies[31] using HUNT data have confirmed the HUNT population follows international health trends for high-income countries, and further details of The HUNT Study and its survey methods can be found elsewhere[32,33] and at the HUNT website.[34] A brief description of the specific variables used in this study are provided in the following sections with further details provided in the supplementary section (Table S-1).

Subject inclusion criteria and occupation classification

Figure 1 illustrates the subject inclusion process. The sample was restricted to HUNT 4 participants that submitted baseline questionnaire 1, their second baseline questionnaire, and completed the interview. Additionally, they must have identified themselves as occupationally active, and the HUNT interviewer must have recorded a most recent occupation category (the STYRK/ISCO category, which the interviewer felt best fit the participants description of their *main* income-earning activities).

Farmers were defined as those currently actively working at the time of survey as a skilled crop or animal production worker (ISCO 61; $n = 1143$) or forestry worker (ISCO 62; $n = 40$). It was observed in the Norwegian Central Coordinating Register for Legal Entities[35] that individuals in the area working in farming frequently include "avvirkning" (logging activities) in their business descriptions, leaving open the possibility of classification as forestry worker by the HUNT interviewer. Fishing, fishery, or aquaculture workers, and hunters (ISCO categories 63 and 64; $n = 147$) were not classed as farmers, as there was no evidence of crop and/or animal production activities in the business register, their workplace exposures are likely to be substantially different to traditional farmers and are themselves highly heterogenous.[36] The remaining workers, excluding military personnel (excluded due to concerns regarding heterogeneity, misclassification, and substantial healthy worker bias, $n = 265$) were categorized following the coding and classification guidelines of the Eurofound European Working Conditions Survey.[37] Figure 1 also shows the number of subjects included with the number of farmers in parentheses. The health and wellbeing outcomes assessed are shown in boxes on the

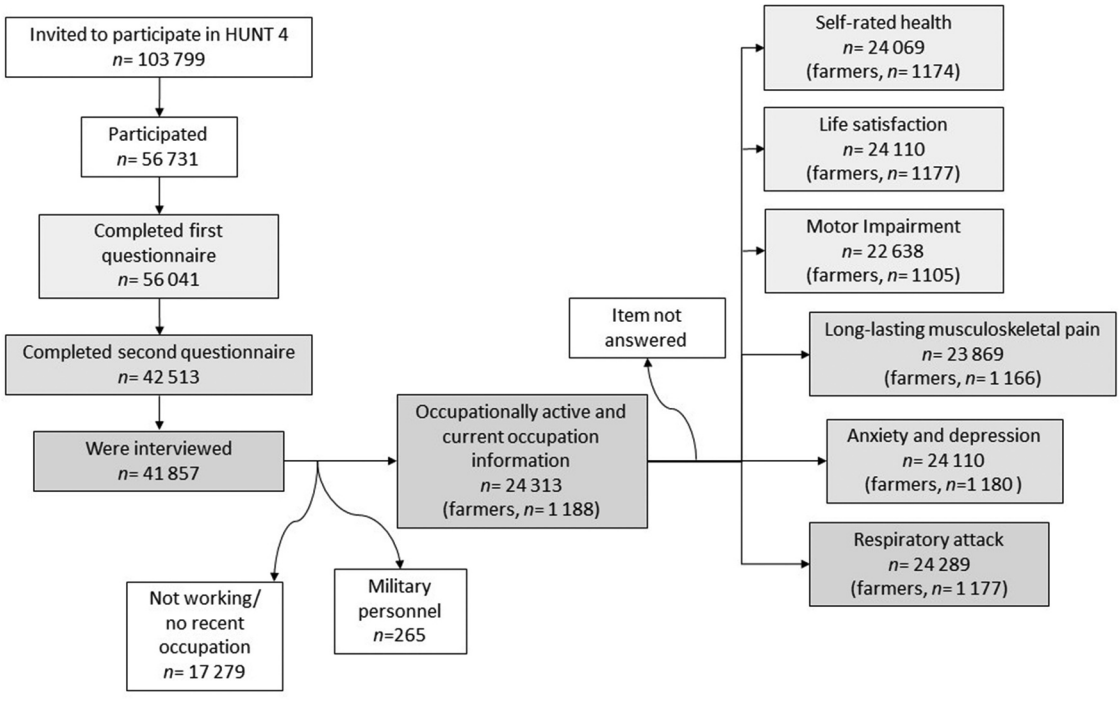

Figure 1. Flowchart of subject inclusion/selection counts (with the count of farmers in parentheses).

right-hand side with the number of subjects with data available on that outcome shown. Chi-squared analysis did not show any significant difference in response rates between occupation groups. Theoretical required sample size calculations based on estimated population prevalences of 50% showed the number of participants included in this study was sufficient to detect statistical differences with 95% confidence (>380 subjects).

Descriptive analysis

To determine the representativeness of the sample, data on the sampling population in 2017 was obtained from a publicly accessible database (Statistics Norway (SSB), www.ssb.no; accessed between Dec.2021 and July 2022), with the population restricted to individuals 20 years or older. For population numbers, ages and sex, data was sourced from SSB table 07459.[38] This table is based on national registry data as of January 1, 2017; whereas the HUNT survey data was collected over 3 years. Occupations were obtained from SSB table 07984, which uses the SIC2007 classification scheme.[39] This is only available at the first level of classification.

Demographic summary statistics were obtained for all workers, the farmers and comparison groups in the sample, as well as for the population from which they were drawn, with mean ages being calculated with a presumption of uniform distribution within age groups when individual level data was not available.

HUNT survey health outcomes

Self-rated health

The question *"All things considered, how do you rate your health at the moment?"* had the response options: *poor, not completely good, good or very good*. For the purposes of this analysis, the responses were dichotomized into "poor or not completely good" and "good or very good".

Life satisfaction

The question *"Thinking about your life at the moment, would you say that you by and large are satisfied with life, or are you mostly dissatisfied?"* had response options on seven point Likert-type scale ranging from *very dissatisfied* to *very satisfied*. For the purposes of this analysis, all responses that did not suggest any degree of satisfaction were combined leaving four categories: "not satisfied", "somewhat satisfied", "satisfied" and "very satisfied", and dichotomized into two categories: "satisfied (to any extent)" and "not satisfied".

Chronically impaired mobility

The question *"Have you had an illness, injury or health condition of at least 12 months duration that impaired your daily life?"* with options *yes* or *no*, was followed by further questions to specify the type and extent of impairment. One of the subcategories was chronic mobility impairment. For the purposes of this analysis, the responses were dichotomized such that any degree of chronic mobility impairment was considered as affected, and those that answered "*no*" to the initial question but did not answer the motor impairment question were assumed to not be affected.

Musculoskeletal pain

The question: *"During the last year, have you had pain and/or stiffness in your muscles and limbs that has lasted for at least 3 consecutive months?"* had the response options: *yes* or *no*.

Work-related respiratory problem

During the HUNT interview, participants were asked: *"Have you ever had respiratory problems from something to do with your work (coughing, expectoration, short of breath or wheezing)?"* with response options: *yes* or *no*.

Symptoms of anxiety, depression or psychological distress

The 14 Hospital Anxiety and Depression Scale (HADS) items[40] were presented to all subjects. For the purposes of this analysis, only individuals who had responded to at least five of the group of seven depression items and at least five of the group of seven anxiety items were included in the analysis, with any missing values extrapolated from the mean for that individual for that subgroup of values, following the method of Gustad, Laugsand, Janszky, Dalen and Bjerkeset[41] and the recommendations of Bell *et al.*[42] For each individual, a total score for anxiety items representing

anxiety symptoms (HADS-A), depression items for depression symptoms (HADS-D), and for all items representing symptoms of psychological distress (HADS-T) were then obtained, giving a range of values for HADS-A and HADS-D of 0–21 and for HADS-T of 0–42.

The HADS scale has been validated for the assessment of anxiety and depression symptoms and overall psychological distress symptoms[43–46] and has been used for earlier studies of farmers' mental health.[11] However, HADS analyses should be viewed with caution, as there is disagreement regarding score categorization and interpretation.[47] As such, this study analyzed the outcomes in two ways:

- "asymptomatic" (<8 for HADS-A/HADS-D; <15 for HADS-T), "mild to moderate symptoms" (8-10 for HADS-A/HADS-D; 15-18 for HADS-T) or "severe symptoms" ($\geq$ 11 for HADS-A/HADS-D; $\geq$ 19 for HADS-T) following the method of Gustad, Laugsand, Janszky, Dalen and Bjerkeset.[41]
- "asymptomatic" (<8 for HADS-A/HADS-D; <15 for HADS-T) or "symptomatic" (≥8 for HADS-A/HADS-D; ≥15 for HADS-T), a threshold supported by Bjelland, Dahl, Haug and Neckelmann.[46]

Exploring associations between occupation and health/wellbeing

Evaluations of associations, with the health and wellbeing outcomes treated as the dependent variables and occupation group as the independent variable, were performed with logistic regression and, where appropriate, proportional ordered logistic regression (*MASS* package version 7.3–57)[48] using R (version 4.2.1).[49]

Directed Acyclic Graph (DAG) analysis[50] was used to identify possible sources of confounding of associations between farming and health outcomes. We concluded that age and sex may be confounders, and estimates were therefore adjusted for age at HUNT 4 participation (to nearest 10th of a year) and sex. Interaction effects were examined, and interaction terms included when supported by Wald's test. A number of other variables were considered intermediates/mediators of the relationship between health and occupation and were consequently not included in the main adjustment set. Education is often considered a confounder in evaluations of associations between occupation and health in other contexts. Highest education level was considered in an earlier analysis of HUNT data.[11] However, in Norway, entry into farming is mostly determined by inheritance,[26,28] with no specific education or training required, and there is evidence that education level and occupation are both indicators of socioeconomic status with "strong mutual associations,"[51] arguing against adjustment for education. Similarly, smoking cannot be considered a classical confounder in this scenario. Nevertheless, sensitivity testing in which we adjusted for education (highest completed level: 10 years of schooling, secondary school, trade qualification, or tertiary education) and smoking (ever a smoker or current smoker) was performed, and also for the exclusion of forestry workers from the farmer category.

The odds and estimated prevalence of each outcome for farmers was compared to that for skilled white collar workers. The estimated prevalences relative to skilled manual workers were also calculated as their workplace exposures may be more similar to farmers than those of skilled white collar workers in terms of exposure to environmental conditions and workloads involving physical exertion. The R package *effects* (version 4.2–2) was used to help calculate predicted prevalences from the regression coefficients.

Ethics and data security

All HUNT 4 participants provided written informed consent for stored data to be used in future research. The project was evaluated by the Regional Committee for Medical and Health Research (REK Nord) (reference 34,574 in 2019, reference 256,719 in 2021) and deemed to not require REK approval due to not falling within that covered by the Health Research Act. The project complies with the Norwegian Personal Data Act and the General Data Protection Regulation (GDPR) for the processing of personal

data. The Norwegian Centre for Research Data (NSD) created a Data Protection Impact Assessment (DPIA) for the project. The data was anonymized before receipt by the researchers, delivered encrypted and stored in encrypted form as per the DPIA.

Results

Demographics in the sample and compared to the sampling population

Table 1 shows that North-Trøndelag had similar demographic characteristics to Norway as a whole. It also shows that while the working participants of HUNT 4 might have been older and more likely to be female than the sampling population, farmers were proportionally represented.

The health of those who were actively working as farmers

Working farmers had observed prevalences (with 95% confidence intervals) of: poor self-rated health 17% (14.5, 18.8), poor life satisfaction 12% (9.8, 13.4), chronically impaired mobility 16% (14.3, 18.7), long-standing musculoskeletal pain 52% (49.3, 55.0), work-related respiratory attack 22% (19.5, 24.2), anxiety symptoms of any severity 15% (12.9, 16.9), depression symptoms of any severity 8% (6.9, 10.0), and symptoms of psychological distress of any severity 11% (9.1, 12.7). The post-adjustment predicted prevalences for farmers and the comparison groups are given in Table 2. The odds ratios and relative prevalences after adjustment are shown in Table 3 and Figure 2

After adjustment for worker age and sex, farmers were predicted to have a prevalence of poor or not so good self-rated health of 16%, which was

Table 1. Demographic details of the study, farmer and comparison groups and the population they were drawn from.

	Sampling population[1] [2]		In this study[3]			
	Norway	North-Trøndelag	All workers	Skilled White Collar Workers	Skilled Manual Workers	Farmers
Count	2 537 740	63 823	24 313	5 374	2 273	1 188
Mean Age (yrs)	43	44	48	49	46	
Mean age of farmers[4] (yrs)	50	49				52
% male	53	53	43	45	93	
% of farmers male[4]	79	80				75
Workforce participation (%)	64[5]	62[5]	43			
% of workforce				22	9	5
% of workforce farmers[4]	2.4	5				
Current smoker (%)			9	5	9	6
Ever a smoker (%)			51	46	55	40

Notes: 1. Residents over 20 years old at January 1st 2017, occupationally active.
2. SSB Table 07984[39].
3. Completed HUNT 4 questionnaire 1, questionnaire 2 and the interview, were occupationally active and gave a current occupation (military excluded).
4. SIC2007 category A or STYRK/ISCO category 61 and 62.
5. SSB Table 07459[38].

Table 2. Observed prevalences of health outcomes and prevalences after adjustment for age and sex, HUNT 4 (2017–2019); all workers, farmers, skilled white collar workers and skilled manual workers.

	Observed prevalence (%) (95% CI)		Prevalence predicted after adjustment for age and sex (%) (95% CI)		
Outcome	Farmers	All workers	Farmers	Skilled white collar workers	Skilled manual workers
Poor or not so good overall health	16.5 (14.5,18.8)	15.0 (14.6,15.5)	15.9 (13.9,18.2)	10.2 (9.4,11.1)	13.4 (11.9,15.0)
Life satisfaction (not satisfied)	11.5 (9.7,13.5)	13.8 (13.4,14.3)	12.5 (10.7,14.7)	10.7 (9.8,11.5)	12.8 (11.4,14.4)
Chronically impaired mobility	16.4 (14.3,18.7)	11.7 (11.3,12.2)	12.9 (11.1,14.9)	7.0(6.4,7.7)	12.0 (10.6,13.5)
Long-standing musculoskeletal pain	52.1 (49.2,55.0)	49.0 (48.3,49.6)	52.8 (49.8,55.7)	40.9 (39.6,42.3)	55.1 (52.9,57.3)
Work-related respiratory attack	21.7 (19.4,24.2)	7.9 (7.5,8.2)	20.9 (18.6,23.4)	4.8 (4.3,5.4)	14.5 (13.0,16.2)
Anxiety symptoms	14.8 (12.8,17.0)	18.1 (17.6,18.6)	17.2 (15.0,19.6)	15.6 (14.6,16.6)	16.9 (15.3,18.7)
Depression symptoms	8.3 (6.8,10.1)	8.0 (7.7,8.3)	8.3(6.8,10.0)	6.4 (5.7,7.1)	9.1 (8.0,10.4)
Symptoms of psychological distress	10.8 (9.1,12.7)	11.5 (11.1,11.9)	11.9 (10.1,14.0)	9.7 (8.9.10.5)	11.82 (10.1,13.3)

Table 3. The crude odds ratios and odds ratios adjusted for age and sex (with 95% confidence intervals) of poor health outcomes in those working as farmers relative to "skilled white collar workers" in the 2017–2019 HUNT survey. *dichotomized; **interaction between age and sex.

		Odds Ratio	
Outcome		**crude**	**adjusted**
Poor or not so good overall self-rated health**		**1.64 (1.38, 1.96)**	**1.66 (1.39, 1.99)**
Life satisfaction	Not satisfied*	1.10 (0.90, 1.35)	1.20 (0.98, 1.47)
	Less satisfied (0–3 score)	**1.12 (1.00, 1.25)**	**1.17 (1.04, 1.31)**
Chronically impaired mobility (>12 months)**		**2.23 (1.85, 2.69)**	**1.96 (1.61, 2.37)**
Long-standing musculoskeletal pain (3 consecutive months of year)		**1.50 (1.32, 1.71)**	**1.61 (1.42, 1.84)**
Work-related respiratory attack (cough, wheeze or dyspnea, ever)		**5.33 (4.43, 6.41)**	**5.20 (4.31, 6.27)**
Anxiety symptoms	Any symptoms*	0.95 (0.79, 1.13)	1.12 (0.94, 1.35)
	More severe symptoms	0.95 (0.79, 1.13)	1.13 (0.94, 1.35)
Depression symptoms	Any symptoms*	**1.35 (1.07, 1.70)**	**1.32 (1.04, 1.68)**
	More severe symptoms	**1.35 (1.06, 1.70)**	**1.32 (1.04, 1.67)**
Psychological distress symptoms	Any symptoms*	1.15 (0.93, 1.41)	**1.27 (1.03, 1.56)**
	More severe symptoms	1.14 (0.93, 1.40)	**1.26 (1.02, 1.55)**

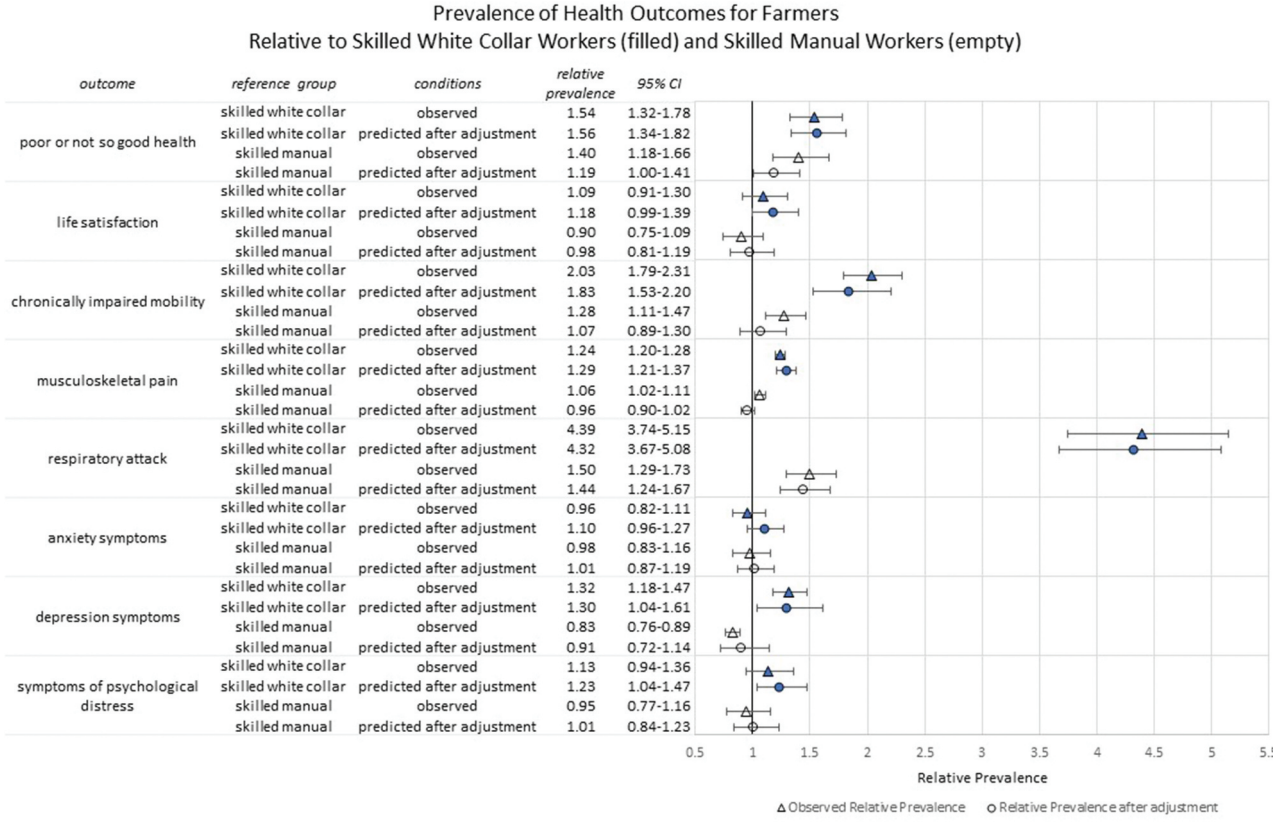

Figure 2. The prevalence ratios, observed and predicted after adjustment for age and sex (with 95% confidence intervals) of poor health outcomes in those working as farmers, relative to skilled white collar workers and skilled manual workers in the 2017–2019 HUNT survey. Health outcomes: - overall self-rated health*; life satisfaction*; mobility impairment that has lasted more than 12 months*; musculoskeletal pain in the past year that lasted at least three months; any work-related respiratory attack (cough, wheeze or dyspnea); anxiety, depression or psychological distress symptoms* (*dichotomized).

56% greater than skilled white collar workers (95% CI of PR: 1.34, 1.82) (Figure 2). Similarly, the predicted prevalence ratio of chronically impaired mobility was 1.83 (1.53, 2.20), long-standing musculoskeletal pain 1.29 (1.21, 1.37), work-related respiratory attack 4.32 (3.67, 5.08), depression symptoms 1.30 (1.04, 1.61), and symptoms of psychological distress 1.23 (1.04, 1.47) relative to skilled white collar workers. In addition, farmers had greater odds of rating themselves less satisfied with life in general than skilled white collar workers (adjusted OR 1.17 [1.04, 1.31]) (Table 3).

Compared to skilled manual workers, farmers also had a higher predicted prevalence of poor or not so good overall health (adjusted prevalence ratio 1.19 [1.00, 1.41]) and work-related respiratory attacks (adjusted prevalence ratio 1.44 [1.24, 1.67]).

Sensitivity analyses

Including highest attained education levels in the adjustment set resulted in only minor changes in the predicted prevalence estimates for farmers, but larger changes in some relative estimates (Tables S-2 and S-3). This was perhaps most notable for symptoms of depression and psychological distress, where the confidence interval for the estimates relative to skilled white collar workers changed to suggest loss of statistical significance. The proportion of farmers who had ever smoked was lower than in either comparison group. The proportion of farmers who were current smokers (of any amount) was lower than that for skilled manual workers and not statistically different to that in skilled white collar workers (p-value 0.19). Excluding the 40 forestry workers from the farmer category had no effect on the estimates.

Discussion

Overall, this cross-sectional analysis of our data suggests farmers have a considerably higher prevalence of poor health and wellbeing outcomes than the comparison groups. Specifically, there appeared to be moderate to strong associations between working as a farmer and poor overall self-rated health, chronically impaired mobility, long-standing joint pain or stiffness, work-related respiratory attack (cough, expectoration, wheeze or dyspnea), and depression symptoms.

The association between working as a farmer and work-related respiratory attack was particularly strong. Smoking rates were not higher in farmers than in the comparison groups. The higher risk of work-related respiratory attack for farmers than for skilled manual workers provides further evidence that such attacks in farmers are due to factors other than older age distribution, being male, or having a physical, outdoor occupation. A previous study[9] also found a strong association between farm work and work-related respiratory attacks in Norwegian farmers, and wheeze, expectoration, and/or dyspnea may be symptoms of non-atopic bronchial inflammation, consistent with findings in Danish farmers[8] and Finnish farmers.[7] Exposure to animal-derived material including endotoxins has been suggested as a possible mechanism for these conditions.[8,16]

We found farmers had higher odds and predicted prevalences of symptoms of anxiety and depression than skilled white-collar workers. When adjusting for education, the association between working as a farmer and symptoms of depression was attenuated and became non-significant. However, both education and occupation are different ways of measuring socio-economic status,[51] and education may be acting as a mediator in the causal pathway between farm work and health, rather than a confounder. It is, therefore, our opinion that adjusting for education is an over-adjustment of the model. Consequently, the model that does not adjust for education is the basis for the following discussion.

The finding of an association between working as a farmer and depression symptoms is consistent with the findings of a study using data from the HUNT 3 survey (2006–2008) in the same county.[11] When comparing the mean crude anxiety and depression scores of farmers in HUNT 3 and HUNT 4, mean anxiety scores were slightly higher in HUNT 4 in both men and women; whereas, the mean depression scores were slightly lower (Table S-4).[11] However, the differences were minor, and these unadjusted means may not be directly comparable. A more in-depth analysis of the difference in strength of association from HUNT 3 to HUNT 4 is beyond the scope of this study. A study of Canadian farmers from 2016 reported substantially higher HADS scores (both on the depression and anxiety subscales) than were seen in this study[12]. These differences may reflect underlying population differences or, alternatively, methodological differences. For example, there is some research to suggest that respondents may over-report psychological distress when they know that they have been recruited to a study due to their occupation.[52] The HUNT Study is a total-population based study, whereas in the Canadian study, the

questionnaire was only sent to farmers. Furthermore, it was not possible to assess selection/participation bias from the latter's published paper. On the other hand, the HUNT Study used the Norwegian translation of the original HADS questionnaire, although this translation has previously been validated.[45] Research to determine if there is actually a true difference in anxiety and depression symptom levels between Canadian and Norwegian farmers, as well as other farming populations, is needed. Similarly, more research is needed to assess the risk factors behind any such differences, such as working environment, social, structural and economic factors.

Together, these current and previous studies increase the strength of evidence for a strong association between respiratory attacks and working as a farmer. This study provides additional evidence that such work may also be associated with a higher prevalence of chronic mobility impairment, long-standing musculoskeletal pain or stiffness, and symptoms of depression and/or psychological distress. More inter-disciplinary research is needed to assess these adverse health outcomes in farmers and the causal pathways, perhaps in particular as regards psychological distress, as well as possible interventions. It is probable that prolonged or cumulative exposures are necessary for differences in prevalence of chronic mobility and long-standing musculoskeletal pain to become evident,[53] and help-seeking reticence[20] may be a contributing factor.

The profound changes in the structure of agriculture over the last decades may also have led to changes in the work environment and job-related exposures,[3,54] and in our study, we could not assess the magnitude, timing, or duration of such exposures at specific farm-level. As farmers age, and as new generations of farmers enter the workforce, working on farms with a different work environment than those experienced by their parents and grandparents, it is important to keep monitoring the health of farming populations. Having updated knowledge on the health and wellbeing of farmers is of importance for everyone who works in the agricultural industry, as well as healthcare professionals who work with farmers, and policy makers.

These results of this study should, with due consideration of any structural societal differences, be generalizable to other high-income countries with seasonal crop and animal agricultural production.

Strengths and weaknesses

Classification and analysis methods used in this study were non-complex with the intention of facilitating replication and meta-analysis. The sample seems reasonably representative of the sampling population. The use of data from a large general population survey with validated measurement instruments and multiple outcomes with consideration of more than one comparison group helps to strengthen the evidence from this study of a general trend in health and wellbeing.

However, we cannot entirely rule out participation bias. Survivor bias is also a consideration in cross-sectional studies of health and occupation, though it should be noted that exit from farming may be more complex than for other occupations due to personal factors (including issues to do with intergenerational relations, the farm as the family home, and psychosocial identity), lack of education, and financial commitments, which may or may not have augmented some estimates. Causal associations cannot be validly attributed. Given the small number of women in farming, stratification of individuals based on sex may give different results.

Conclusions

This cross-sectional study provides evidence that working as a farmer is associated with poor health and wellbeing. It is based on data collected in Norway during 2017–2019 as part of a large population survey. The association was particularly strong for work-related respiratory attack, and moderately strong for poor overall (self-rated) health, chronically impaired mobility, long-standing musculoskeletal pain or stiffness, and symptoms of depression. The association with work-related respiratory attack was greater for farmers than for skilled manual workers in the same region of the country after adjustment for age and sex, suggesting exposure factors other than demographic characteristics; the

weather or physical exertion may be involved. The findings are broadly consistent with earlier research on this population and with research involving other farming populations and supports a theory of general increased risk to farmers' health and wellbeing in high-income countries with diverse, seasonal crop and animal production. These findings are relevant to occupational health researchers and those responsible for rural health and safety or food security policies.

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Abbreviations

CI	Confidence interval
EEA	European Economic Area
EU	European Union
HUNT	Helseundersøkelse i Trøndelag (The Trøndelag Health Study)
ISCO	The International Standard Classification of Occupations
OR	Odds ratio
PR	Prevalence ratio
SIC	Standard Industrial Classification
SSB	Statistics Norway
STYRK	Standard for Yrkesklassifisering (STYRK- 88 was based on ISCO-88)

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