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Work exposures and mental and musculoskeletal symptoms in organic farming

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ABSTRACT

This study focussed on harmful exposures and mental and musculoskeletal symptoms in organic and conventional farming using interview data of Finnish farmers over the winter of 2014–2015. The data consisted of 2,169 full-time farmers, out of whom 231 (11%) practiced organic farming and 1,938 (89%) conventional farming. Exposure to poisonous and irritating substances was less frequent while exposures to vibration and mould ('smell of root cellar') were more frequent on organic farms. Mental and musculoskeletal symptoms were slightly more common among organic farmers, but the associations were not statistically significant in regression modelling. Risk factors for mental symptoms included animal production, hired labour, female gender, constant hurry, working alone, economic uncertainty, and inadequate recovery from workdays. Risk factors for musculoskeletal symptoms included older age, female gender, constant hurry, economic uncertainty, difficult working postures, heavy lifting and carrying, and inadequate recovery. Workload and recovery, managing the transition period and better follow-up of the occupational well-being were identified as concerns among organic farmers.

Practitioner summary: Converting from conventional to organic farming has become increasingly common. Farmer interviews indicated that exposure to poisonous and irritating substances was less frequent while exposures to vibration and mould were more frequent on organic farms. Mental and musculoskeletal symptoms and risk factors were similar in both types of farming.

Abbreviations: CS: CASH: Central States Center for Agricultural Safety and Health; UNMC: University of Nebraska Medical Center; OE: occupational exposures; MSS: musculoskeletal symptoms; Org. Agric: organic agriculture; Soc. sust.: social sustainablity

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Introduction

Organic farming is a form of agriculture that is based on ecological systems and soil fertility instead of intensive use of artificial chemicals, pesticides, herbicides, and routine animal medication. In addition to its ecological base, the principles of organic agriculture also include fairness, care, and health of '*the smallest in the soil to human beings*' (IFOAM 2020). This definition implies that the health of producers and workers, and the control of physical and mental stressors at work should be integral parts of organic farming.

The area under organic farming has been increasing globally (Willer et al. 2020). In Europe (EU-28), the organic agricultural farmland was 13.4 million hectares (7.5% of the total utilised agricultural area) in 2018 (Eurostat 2020). In Finland, the organic area covered 13.5% of total farmland in 2019, and 5,039 farms (10.7% of all farms) were practicing organic production (Finnish Food Authority 2020). Organic farmland was mainly used for cultivated grass, oat, and other plant production including oil plants, legumes, potatoes, and silage grain.

Our earlier studies indicate that organic farming has a negative association with work ability, but we could not determine the contribution of pre-existing disabling conditions or the farmers' health status before switching to organic farming (Mattila et al. 2020). Cranfield, Henson, and Holliday (2010) reported that health and safety concerns are among the most important motivators for farmers to convert from conventional to organic farming. This could be linked to heightened awareness and reporting of symptoms

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among organic farmers. However, there may also be protective factors that are unique to organic farming (Brigance et al. 2018). Further, research also suggests that farmers in good health are more willing to adopt organic methods (Karali et al. 2014).

In general, farm work increases the risk for declined work ability (Gould et al. 2008; Saarni, Saarni, and Saarni 2008) and a disability pension (Pensola, Gould,and Polvinen 2010). Musculoskeletal disease is the most common (44.6%) reason for disability pension among Finnish farmers, followed by mental and behavioural disorders (17.5%) and injuries (9.8%) (Karttunen, Rautiainen, and Leppälä 2015). These studies did not differentiate between organic and conventional farming.

Risk factors for musculoskeletal disorders in agriculture vary between production sectors. In grain production, vibration and prolonged vigilance are frequent due to long tractor-driving hours (Fathallah 2010). Long tractor-driving hours (over 1,000 h per year) increase the risk for sick leave due to back disorders (Hartman et al. 2006). Horticultural field production includes extreme climates, vibration, noise, repetitive cutting, prolonged and repetitive stooping, and lifting and carrying heavy loads (Fathallah 2010). In dairy farming, the exposures depend on the cowshed and milking system designs. Lifting and carrying equipment and other heavy loads as well as awkward working positions cause trouble to shoulders, the lower back, and knees in tethered milking systems, whereas working in more modern milking stations (in loose-house systems) includes repetitive and monotonous work, which causes trouble particularly for the upper extremities (Douphrate, Nonnenmann, and Rosecrance 2009; Pinzke 2016). Other work phases are usually more mechanised in loose-housing systems than in tethered systems, and working with milking robots reduces these symptoms (Pinzke 2016). Commonly, the used technology (Pinzke 2016), workplace organising and practices (Faucett et al. 2007; Fathallah 2010), working hours (Osborne et al. 2010), and years of farming (Kang et al. 2016) influence the risk of farmers' musculoskeletal disorders as well as lifestyle issues, such as smoking and body-mass index being >27 (Hartman et al. 2006).

Work systems may change in many ways when converting from conventional to organic production. Organisation of work is one of the major challenges (Navarrete, Dupré, and Lamine 2015; Chizallet, Barcellini, and Prost 2018). While the change can be an opportunity to improve working and living conditions, the implementation may be difficult as it is dependent on the farmer's skills, resources, and economic situation, which might be overextended particularly during the transition period (Chizallet, Barcellini, and Prost 2018; Väre et al. 2021). An increase in labour-intensive methods (e.g. manual or mechanical weeding instead of spraying) may increase musculoskeletal symptoms (Hanson 2013). A study in Thailand found reduced pesticide-related symptoms and increased musculoskeletal symptoms in organic farmers, but no difference in mental symptoms (depression) (Nankongnab et al. 2020). In Finland, organic farmers have experienced more mental strain due to farm management (Väre et al. 2021). In relation to mental health, financial strain, lack of control over external factors, the responsibility of ownership, workload, and troubles with balancing work and life have been recognised as risk factors among organic farmers (Brigance et al. 2018). According to Yazd, Wheeler, and Zuo (2019), the most cited influences on farmers' mental health were pesticides exposure, financial problems, unpredictable weather, poor physical health, and past injuries.

The purposes of this study were to evaluate if the prevalence of harmful exposures is different in organic farming *vs.* conventional farming and if organic farming is a risk factor for musculoskeletal and mental symptoms, which are the most frequent disabling conditions among Finnish farmers.

Materials and methods

Our study used telephone interview data collected by the Finnish Institute of Occupational Health (FIOH) over the winter of 2014–2015. Farmers' contact information was obtained from the register of the Agency for Rural Affairs. The sampling frame consisted of Finnish farmers who applied for agricultural subsidies in 2014 ($n = 48{,}277$ farmers). The stratified random sample included 5,774 farmers; 1,287 of them could not be reached, and 1,370 refused to participate. The stratified sample represented 12 major agricultural production sectors in Finland (Perkiö-Mäkelä et al. 2016). The study plan was reviewed and accepted by the Ethics Committee of FIOH. The initial research dataset consisted of 3,117 active farmers between 18 and 68 years of age (response rate 54%) with a large selection of validated questions concerning work exposures, health outcomes, and personal and production-related characteristics. As the part-time farmers were not asked questions about harmful exposures and mental and musculoskeletal symptoms in the interview, they were excluded from our study. The final subset of interview data for our analysis consisted of 2,169 full-time farmers, out of whom 231 (11%)

practiced organic farming and 1,938 (89%) conventional farming. A farm was classified as organic if organic concepts were used in plant production, in animal production, or both, based on the farmer's answer to the question 'Is the crop farming or animal production of your farm in organic production?' The share of organic farmers was similar in the study population and the general farming population. Data from the FIOH telephone interview survey have been used earlier by Perkiö-Mäkelä and Hirvonen (2018) in their analysis of health and work-related dimensions of current work ability, by Mattila et al. (2020) for analysis of the determinants of good work ability among organic and conventional farmers, and by Väre et al. (2021) in their analysis of farm management practices and development plans on organic farms.

Outcome variables

In the interview, farmers were asked to self-assess each harmful work exposure with nine questions: 'How much does (this work exposure) disturb you in your work on the scale of not at all, a little, quite a lot, very much, or don't know?' Classes of 'quite a lot' and 'very much' were merged in the analysis due to a small number of observations in some sub-groups. The nine assessed work exposures were (1) difficult working postures, (2) heavy liftings and carrying, (3) noise, (4) vibration, (5) weak or blinding light, (6) gases or air quality in the production building, (7) dust, (8) smell of mould or root cellar, and (9) poisonous or irritating substances.

Farmers' mental symptoms were assessed with five questions: 'During the previous month, have you had long-term: (1) weakening of memory or ability to concentrate, (2) depression or melancholy, (3) powerlessness and tiredness, (4) insomnia or difficulty to fall asleep, and (5) irritability or annoyance?' Alternative response options for each symptom were 'yes', 'no', or 'don't know'.

Musculoskeletal symptoms were assessed with seven questions: 'During the previous month, have you had long-term or repeated trouble/pain/ache in the (1) neck or shoulders, (2) arms, (3) wrists and fingers, (4) lumbar region, (5) hip, (6) knees, (7) other parts of feet?' Alternative responses for each symptom were 'yes', 'no', or 'don't know'.

Potential risk factors for mental and musculoskeletal symptoms

Our main interest was to identify if organic farming increased the risk of mental and musculoskeletal outcomes. Other potential risk factor variables were selected based on earlier analyses of these data (Perkiö-Mäkelä et al. 2016), risk factors identified in the literature, and potential novel risk factors available in the interview data (Table 1).

Statistical methods

The chi-square test was used to analyse the association of the conventional *vs.* organic farming method with each work exposure and each mental and musculoskeletal symptom. Logistic regression analysis was used to identify risk factors for mental and musculoskeletal symptoms. For the logistic regression analysis (binary logit), both mental and musculoskeletal symptoms were re-classified into two classes: yes/no ('yes' if having any symptoms, otherwise 'no'). Multivariable analyses were conducted using the full model method. All significant variables ($p < 0.05$) were included in the final multivariable models (Tables 5 and 6). The performances of the final models were tested using the concordance index, which was 0.725 for the model of mental symptoms and 0.701 for the model of musculoskeletal symptoms indicating satisfactory performance (Hanley and McNeil 1982). The results of the Hosmer and Lemeshow test showed no evidence of lack of fit in the selected models, $p = 0.7240$ and $p = 0.6447$, respectively (Hosmer and Lemeshow 2000). Analyses were conducted using the SAS for Windows version 9.4.

Results

According to the chi-square tests, vibration, smell of mould or root cellar, and poisonous or irritating substances had an association with the farming type (organic/conventional farming). Exposure to poisonous or irritating substances was less frequent and exposures to vibration and mould were more frequent among organic farmers (Table 2).

All five mental symptoms during the previous month were more prevalent among organic (*vs.* conventional) farmers: long-term weakening of memory or ability to concentrate (18 *vs.* 10%), depression or melancholy (20 *vs.* 13%), powerlessness and tiredness (40 *vs.* 32%), insomnia or difficulty to fall asleep (23 *vs.* 17%), and irritability or annoyance (31 *vs.* 24%) (Table 3). Each mental symptom was also associated with the farming method based on chi-square tests (Table 3). More than half (52%) of the organic farmers and nearly half (46%) of the conventional farmers had at least one mental symptom (Table 4). Having

Table 1. Potential risk factors for mental and musculoskeletal symptoms.

Potential risk factor	Organic farmers		Conventional farmers		Total	
	n	%	*n*	%	*N*	%
Farming method[a,b]						
Organic					231	11
Conventional					1,938	89
*Main production sector[a,b]						
Animal production	142	61	1,147	59	1,289	59
Plant production	89	39	791	41	880	41
Hired farm labor[a,b]						
Yes	84	36	574	30	658	30
No	147	64	1,364	70	1,511	70
Farmer's age[a,b]						
18–50 years	113	49	922	48	1,035	48
51–68 years	118	51	1,016	52	1,134	52
Farmer's gender[a,b]						
Female	43	19	199	10	242	11
Male	188	81	1,739	90	1,927	89
**Agricultural education[a]						
Lower	147	64	1,416	73	1,563	72
Higher	84	36	515	27	599	28
Strain of constant hurry and tight schedule[a,b]						
Often	74	32	478	25	552	26
Never, rarely, occasionally	157	68	1,455	75	1,612	74
Strain of working alone[a]						
Often	35	15	257	13	292	14
Never, rarely, occasionally	195	85	1,674	87	1,869	86
Strain of economic uncertainty[a,b]						
Often	58	25	391	20	449	21
Never, rarely, occasionally	173	75	1,540	80	1,713	79
Recovering after the working day[a,b]						
Weak or moderate	145	63	1,260	65	1,405	65
Good	85	37	670	35	755	35
Harm from difficult working postures[b]						
Quite a lot or very much	63	27	416	21	479	22
Not at all or a little	168	73	1,522	79	1,690	78
Harm from heavy liftings and carrying[b]						
Quite a lot or very much	60	26	401	21	461	21
Not at all or a little	171	74	1,536	79	1,707	79
Body Mass Index (BMI)[b]						
Normal 18.5–24.9	82	36	679	35	761	35
Other	145	64	1,245	65	1,390	65
Tractor-driving hours per year[b]						
0–500 h	110	48	893	46	1,003	47
Over 500 h	120	52	1,030	54	1,150	53

*Animal production included dairy, beef, and other livestock production (pig, poultry, goat, sheep, horse, and other animals); Plant production included cereal, other plant production (potato, root plant, vegetable, greenhouse, hay, other plants, and forestry).
**Lower if having no professional studies, only courses or the lowest level of professional studies; higher if having a university, university or applied sciences, or college-level education.
[a]Tested for mental symptoms.
[b]Tested for musculoskeletal symptoms.

multiple mental symptoms was more common among organic farmers (Chi-square test $p = 0.0003$) (Table 4).

Logistic regression modelling showed that animal production, hired farm labour, female gender, feeling strain often because of constant hurry and tight schedules, experiencing strain often because of working alone, experiencing economic uncertainty often, and experiencing only weak or moderate recovery after the working day were risk factors for mental symptoms (Table 5). When using a dichotomised outcome variable (any mental symptoms yes/no), the organic *vs.* conventional farming method was not among significant risk factors in the final adjusted regression model, nor in the unadjusted model (OR: 1.25, 95% CI: 0.95–1.64).

During the previous month, 45% of the organic farmers had experienced long-term or repeated trouble/pain in the neck and shoulders, 44% in arms, 24% in wrists and fingers, 41% in the lumbar region, 18% in hips, 30% in knees, and 20% in other parts of feet. There was no association between the farming method and musculoskeletal symptoms based on chi-square tests in any of these body parts, except in the other parts of feet ($p = 0.02$). Overall, 74% of the organic farmers and 71% of the conventional farmers reported at least one musculoskeletal symptom (Table 4). In the final adjusted logistic multivariable model, age over 50 years, female gender, feeling strain often because of constant hurry and tight schedules, experiencing economic uncertainty often, difficult

Table 2. Self-reported work exposures on organic and conventional farms.

Work exposures and categories	Total	Number and share of organic farmers	Number and share of conventional farmers	Chi-square, *p*-value
Difficult working postures				0.1315
Not at all	287 (13%)	28 (12%)	259 (13%)	
A little	1,403 (65%)	140 (61%)	1,263 (65%)	
Quite a lot/very much	479 (22%)	63 (27%)	416 (21%)	
Heavy liftings and carrying				0.1710
Not at all	382 (18%)	40 (17%)	342 (17%)	
A little	1,325 (61%)	131 (57%)	1,194 (62%)	
Quite a lot/very much	461 (21%)	60 (26%)	401 (21%)	
Noise				0.9084
Not at all	542 (25%)	56 (24%)	486 (25%)	
A little	1,298 (60%)	141 (61%)	1,157 (60%)	
Quite a lot/very much	324 (15%)	33 (14%)	291 (15%)	
Vibration				0.0011
Not at all	880 (41%)	77 (33%)	803 (41%)	
A little	1,130 (52%)	125 (54%)	1,005 (52%)	
Quite a lot/very much	157 (7%)	29 (13%)	128 (7%)	
Weak or blinding light				0.1084
Not at all	936 (43%)	85 (37%)	851 (44%)	
A little	1,077 (50%)	129 (56%)	948 (49%)	
Quite a lot/very much	153 (7%)	17 (7%)	136 (7%)	
Gases or air quality in production building				0.8641
Not at all	1,325 (61%)	145 (63%)	1,180 (61%)	
A little	762 (35%)	78 (34%)	684 (35%)	
Quite a lot/very much	80 (4%)	8 (3%)	72 (4%)	
Dust				0.3006
Not at all	338 (16%)	28 (12%)	310 (16%)	
A little	1,421 (66%)	157 (68%)	1,264 (65%)	
Quite a lot/very much	407 (19%)	46 (20%)	361 (19%)	
Smell of mould or root cellar				0.0025
Not at all	1,549 (71%)	145 (63%)	1,404 (73%)	
A little	517 (24%)	68 (29%)	449 (23%)	
Quite a lot/very much	99 (5%)	18 (8%)	81 (4%)	
Poisonous or irritating substances				<.0001
Not at all	1,292 (60%)	167 (72%)	1,125 (58%)	
A little	798 (37%)	54 (23%)	744 (38%)	
Quite a lot/very much	77 (3%)	10 (4%)	67 (3%)	

Table 3. Long-term mental symptoms among full-time organic and conventional farmers.

Mental symptom	Total	Number and share of organic farms	Number and share of conventional farms	Chi-square, *p*-value
Weakening of memory or ability to concentrate				
No	1,928 (89%)	189 (82%)	1,739 (90%)	0.0003
Yes	241 (11%)	42 (18%)	199 (10%)	
Depression or melancholy				
No	1,879 (87%)	185 (80%)	1,694 (87%)	0.0020
Yes	290 (13%)	46 (20%)	244 (13%)	
Powerlessness and tiredness				
No	1,448 (67%)	139 (60%)	1,309 (68%)	0.0246
Yes	721 (33%)	92 (40%)	629 (32%)	
Insomnia or difficulty to fall asleep				
No	1,786 (82%)	177 (77%)	1,609 (83%)	0.0159
Yes	383 (18%)	54 (23%)	329 (17%)	
Irritability or annoyance				
No	1,625 (75%)	159 (69%)	1,466 (76%)	0.0239
Yes	544 (25%)	72 (31%)	472 (24%)	

working postures that harm quite a lot or very much, heavy lifting and carrying that harm quite a lot or very much, and only weak or moderate recovery after the working day were identified as risk factors for musculoskeletal symptoms (Table 6). The organic or conventional farming method was not a significant risk factor in the multivariable model, or in the univariable logistic regression model (OR 1.14, 95% CI: 0.84–1.56), when using a dichotomised outcome variable (any musculoskeletal symptoms yes/no).

Table 4. Number of mental (scale 0–5) and musculoskeletal (scale 0–7) symptoms of organic and conventional farmers.

	Number of health symptoms, *n* (%)								
	0	1	2	3	4	5	6	7	Chi-square, *p*-value
Mental symptoms									0.0003
Organic farmers	111 (48%)	38 (16%)	28 (12%)	19 (8%)	20 (9%)	15 (6%)			
Conventional farmers	1,037 (54%)	393 (20%)	221 (11%)	152 (8%)	93 (5%)	42 (2%)			
Musculoskeletal symptoms									0.1487
Organic farmers	60 (26%)	45 (19%)	37 (16%)	29 (13%)	19 (8%)	21 (9%)	13 (6%)	7 (3%)	
Conventional farmers	555 (29%)	380 (20%)	361 (19%)	272 (14%)	159 (8%)	116 (6%)	55 (3%)	40 (2%)	

Table 5. Risk factors for mental symptoms among full-time farmers.

	Frequency	OR*	95% CI
Production sector			
Plant production	868	Ref.	
Animal production	1,275	1.26	1.04–1.52
Farm labour			
No	1,496	Ref.	
Yes	647	1.30	1.06–1.59
Gender			
Male	1,902	Ref.	
Female	241	1.74	1.29–2.34
Strain of constant hurry and tight schedules			
Never, rarely or occasionally	1,597	Ref.	
Often	546	1.82	1.46–2.29
Strain of working alone			
Never, rarely or occasionally	1,854	Ref.	
Often	289	1.83	1.37–2.44
Strain of economic uncertainty			
Never, rarely or occasionally	1,701	Ref.	
Often	442	1.75	1.38–2.23
Recovering after working day			
Good	751	Ref.	
Weak or moderate	1,392	3.16	2.57–3.88

*Adjusted.

Table 6. Risk factors for musculoskeletal symptoms among full-time farmers.

	Frequency	OR*	95% CI
Age			
18–50	1,028	Ref.	
51–68	1,121	1.29	1.06–1.58
Gender			
Male	1,907	Ref.	
Female	242	1.54	1.08–2.19
Strain of constant hurry and tight schedules			
Never, rarely, or occasionally	1,602	Ref.	
Often	547	1.50	1.15–1.95
Strain of economic uncertainty			
Never, rarely or occasionally	1,704	Ref.	
Often	445	1.49	1.12–1.98
Harm from difficult working postures			
Not at all/a little	1,675	Ref.	
Quite a lot/very much	474	3.15	2.15–4.61
Harm from heavy liftings and carrying			
Not at all/a little	1,692	Ref.	
Quite a lot/very much	457	2.75	1.86–4.06
Recovery after working day			
Good	753	Ref.	
Weak or moderate	1,396	1.48	1.20–1.82

*Adjusted.

Discussion

The increase in the number of organic farms has raised the question if organic farming differs from conventional in terms of working conditions and the farmers' health. A recent study found that organic farming was associated with declined work ability, while the research method did not identify specific disabling conditions (Mattila et al. 2020). The current study focussed on potentially harmful exposures in organic (*vs.* conventional) farming and the association of the farming method with musculoskeletal and mental health symptoms based on interview data.

The results indicate that exposures to vibration and mould were more frequent among organic farmers. Being exposed (quite a lot or very much) to vibration and mould was nearly twice as frequent among organic farmers. The use of agrichemicals is reduced in organic farming, and it is possible that the use of alternative methods, such as mechanical weeding, exposes farmers to whole-body or hand vibration. However, farmers' work varies greatly, and exposure measurements would be needed to identify vibration risks in the different work phases and different farm settings. Hand-transmitted vibration could be evaluated using a standard method (ISO 5349-1), and smartphones could offer possibilities to measure whole-body vibration (Wolfgang, Di Corleto, and Burgess-Limerick 2014). A literature review of Essien et al. (2018) found that the association of whole-body vibration exposure and lower-back disorders among farmers is still unclear.

Dust exposure is common in farm environments and we found no difference in self-reported dust exposure based on the farming method (organic *vs.* conventional). However, organic farmers reported a more frequent smell of mould and root cellar. This is concerning as moulds and organic dust are related to many respiratory diseases and symptoms among farmers (Suominen and Putus 2020). Further, Zukiewicz-Sobczak et al. (2013a, 2013b) have found that the composition of organic dust is partly different on organic and conventional farms.

Exposure to poisonous or irritating substances was less frequent among farmers practicing organic farming. Based on earlier studies, reduced chemical exposure could have a protective effect on mental health conditions (Kallioniemi et al. 2009; Yazd, Wheeler, and

Zuo 2019), but such association was not found in our study.

Mental symptoms, particularly long-term powerlessness and tiredness, were frequent among all farmers, and at the same level as found earlier in a similar study by Perkiö-Mäkelä and Hirvonen (2013). They reported that 51% of farmers have at least one mental symptom, the most typical being long-term powerlessness and tiredness. In our study, 52% of farmers practicing organic farming and 46% of those practicing conventional farming suffered from at least one mental symptom during the past month. Having several different mental symptoms was frequent among farmers practicing organic farming; 35% ($n = 82$) of organic farmers had experienced 2–5 long-lasting mental symptoms during the previous month, which shows the clear need for actions supporting the farmers' mental well-being.

Choosing an alternative farming method requires new skills and professional competence, and this may cause added mental stress. Converting from conventional to organic farming has an impact on farming methods, and it also increases the inherent production risks (Koesling et al. 2004; Koesling et al. 2012) due to the changing market situations and restrictions imposed by organic practices. The transition period may also be hard financially as the yields are lower and the price premiums for organic products are not yet achieved. Transition takes time and learning (Sipiläinen and Oude Lansink 2005). The importance of management and marketing skills, and the challenges in gaining professional competence needed in organic farming, have been highlighted in several studies (e.g. Koesling et al. 2004; Koesling et al. 2012).

The farming method (organic/conventional) was not among risk factors for mental symptoms in regression modelling where the outcome variable was dichotomised. Similar findings were made by Nankongnab et al. (2020) although from different farming circumstances in Thailand. Brigance et al. (2018) suggested both stressors and protective factors may be unique in organic farming; e.g. feelings of social and environmental responsibility may be protective. While no significant association was found in the present study, differences in stressors and protective elements could exist between conventional and organic farms. Organic farming is very diverse. For example, organic dairy farms have become larger than conventional ones on average whereas opposite development has occurred in pig production (Finnish Food Authority 2020; Niemi and Väre 2019). Organic crop production has become highly concentrated where few large farms dominate production. For example, acquiring machinery for carrot production is often unprofitable for smaller farms (Koivisto et al. 2020), which favours concentration (Iivonen et al. 2014) and creates very different working circumstances depending on farm size.

Identified risk factors for mental symptoms in our analysis included animal production, having hired farm labour, female gender, feeling strain often because of constant hurry and tight schedules, experiencing strain often because of working alone, experiencing economic uncertainty often, and experiencing only weak or moderate recovery after the working day. In earlier studies, Karttunen and Rautiainen (2013) found male gender, larger farm size, and cattle production among risk factors for injuries and occupational diseases among Finnish farmers. Kolstrup (2008) noticed that Swedish farmers who have healthier cattle have difficulties in maintaining their own health.

Managing farm labour is challenging for many farmers (Mattila et al. 2007). Navarrete, Dupré, and Lamine (2015) reported that organising crop production and labour on diversified farms may be very complex when converting to organic farming, which may result in severe stress and workload. Chizallet, Barcellini, and Prost (2018) also described organisation of work as a substantial challenge for farmers in achieving their goals when changing towards agroecological practices. Increasing farm sizes, growth in organic farming, and greater labour input after converting to organic (Morison, Hine, and Pretty 2005) require better management training and education for farmers; this is also critical for farmers' workload and health. The transition phase is particularly challenging and new ways of managing change should be considered in research and development actions.

Opposite to our finding, Logstein's (2016) study of Norwegian farmers suggested that even if female farmers (and younger farmers) were more concerned about their farm economy and not able to do all needed tasks, no associations between age, gender, and mental health were found. Similar to our findings, Logstein (2016) found that concerns about the economy and lack of time for all work tasks have a significant effect on mental complaints. This study did not differentiate between organic and conventional farms. The literature review of Yazd, Wheeler, and Zuo (2019) mentioned financial difficulties and heavy workload in the top five mental health risk factors among farmers. Others were pesticide exposure, weather uncertainty, and poor physical health or past injury. Isolation and loneliness are mentioned in the top seven (Yazd,

Wheeler, and Zuo 2019). In Finland, Kallioniemi et al. (2016) found poor economic situation, workload and own health, and loneliness being associated with stress symptoms among dairy farmers.

Inadequate recovery after the working day was a strong predictor for mental symptoms in our modelling where 65% of all farmers ($n = 1,392$) reported weak or moderate recovery. A review by Verbeek et al. (2019) found some possibly effective interventions for improving recovery from cognitive and physical workload, such as relaxation, recovery training, physical activity, stress management, participatory changes, breaks, and task variations. These preventive measures should be further evaluated in a farming context where farmers' occupational health service providers could include these methods as part of their health education. However, the solutions should probably be broader, starting from the overall challenges that farmers are facing. The average farm size in Finland grew from 39 hectares (ha) to 49 ha during the period 2010–2019 (26% increase) (Luke 2020). Despite the increasing farm size, agricultural profitability has been weak for a longer time (Economydoctor 2020). Between 2013 and 2016, the annual workload in agriculture and horticulture enterprises in Finland, measured in person-years, decreased by 16%. The share of work (measured in full-time equivalent annual work units, AWU) performed by self-employed farmers and joint owners increased slightly (0.4%). At the same time, the share of work performed by the regularly hired labour decreased (−2.1%) and the share of work performed by holiday relief staff (+1.9%) and foreign labour force (+1.4%) increased (Luke 2018). Based on these statistics, it seems that farmers replace regularly hired labour with their own work and by hiring more short-term labour.

Musculoskeletal symptoms are common among farmers. In our data, 72% of all farmers suffered some musculoskeletal symptoms. The most common symptoms among organic farmers were pain in the neck and shoulder region (45%), arms (44%), and the lumbar region (41%). These findings are similar to the earlier findings of Perkiö-Mäkelä and Hirvonen (2013) among all Finnish farmers. They reported that 65% of farmers had at least one musculoskeletal symptom, most commonly in the lumbar (44% of farmers) or neck and shoulder regions (43% of farmers). Pinzke (2016) found that 79.0% of male and 88.5% of female dairy farmers in Sweden had musculoskeletal symptoms on some occasions. Du et al. (2021) reported a prevalence of 59% among farmers in the central United States.

Similar to mental symptoms, female gender, feeling strain often because of constant hurry and tight schedules, experiencing economic uncertainty often, and only weak or moderate recovery after the working day were also among risk factors for musculoskeletal symptoms. Awkward working postures and heavy lifting and carrying were the strongest risk factors for musculoskeletal symptoms; well-recognised also in earlier studies (Douphrate, Nonnenmann, and Rosecrance 2009; Kang et al. 2016). It is concerning that there appears to be no improvement over time in farmers' musculoskeletal symptoms.

Ergonomic improvements, particularly those related to handling heavy loads, should be made to reduce the physical workload in agricultural work on both organic and conventional farms. This includes development in the working environment and methods, the use of assistive technology, appropriate tools, and the planning of work practices. In Finland, farmers may seek assistance from occupational health service (OHS) specialists. All farmers can join the voluntary farmers occupational health service (FOHS), based on the Occupational Health Care Act. FOHS includes periodic health cheques, farm visits, and health education. Curative services can also be arranged as part of FOHS which has a relatively low annual membership fee, subsidised from tax revenues (Taattola et al. 2006; Kinnunen, Manninen, and Taattola 2009).

Strength and limitations

The strengths of this study include a relatively large and representative sample of Finnish farms and the use of validated questions for exposures and health outcomes. A weakness is that organic farmers are still a small minority. Since the study sample was not stratified based on the farming method (organic *vs.* conventional), the number of organic farmers was quite low which reduces power in statistical comparisons by the farming method. The farmers' health status before switching to organic farming and years practicing organic farming was not known. Therefore, we could not determine to what extent the musculoskeletal symptoms were based on pre-existing (pre-organic) conditions. Furthermore, the data were based on self-reporting which can introduce biases. The sample came from the northern geographic region, which needs to be considered before generalising results to other contexts.

Conclusion

Mental and musculoskeletal symptoms were frequent in this study population. Exposures to vibration and

mould were more frequent while chemical exposures were less frequent on organic farms. While mental and musculoskeletal symptoms were slightly more common among organic farmers, these findings were not statistically significant in regression modelling. The production of organic food does not appear to be healthier for the producers. The critical issues for future improvement involve reducing the workload, improving recovery, managing work organisation and the transition (from conventional to organic) period, and establishing better follow-up of occupational well-being of farmers and farm workers. Overall, working conditions and challenges in organic farming need to be considered as part of the future goals of this sector. The European Farm to Fork strategy highlights an urgent need to increase organic farming to slow down climate change and environmental degradation (European Commission 2021). Economic resources and the well-being of farmers are critically important in achieving these goals, and also making organic production attractive for farmers and farm workers.

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