Risk Factors for Occupational Injuries among Full-Time Farmers in Finland

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ABSTRACT. *The objectives of this study were to evaluate the frequency of and farm management-related risk factors for occupational injuries among full-time farmers. A computer-assisted telephone interview was conducted among randomly selected self-employed full-time farmers (n = 1182; 911 male and 271 female). The response rate was 86%. Two-thirds of the respondents raised dairy or beef cattle. Nearly 16% of the farmers had experienced one or more occupational injuries requiring medical consultation during the past 12 months; the total number of such injuries was 222. Injuries were more common among male (17 injuries/100 person-years) than female farmers (13 injuries/100 person-years). The injuries occurred most frequently in animal husbandry work (n = 97). Falling or slipping was the most common mechanism of injury. Poisson regression with a stepwise (forward) model selection procedure identified the following risk factors for occupational injuries: male gender, younger age, cooperation with other farmers, perceived high accident risk, and stress symptoms. The adjusted rate ratios for these risk factors ranged from 1.40 to 1.96. This study indicates that interventions are needed, particularly among male farmers in their early years of full-time farm operation. At this stage of life, heavy financial burden and stress while establishing and expanding production may contribute to injuries. To reduce stress and related injuries, we recommend guidance for farmers regarding the organization and management of farm work.*

Keywords. *Age, Agriculture, Farm, Gender, Health, Injury, Management, Risk, Stress.*

Agricultural employment has decreased notably worldwide in past decades (USDA, 2010; Eurostat, 2010). In Finland, the number of agricultural holdings has also decreased, but the amount of arable land has remained quite stable (Tike, 2010, pp. 42-43). In 2004, there were about 72,000 active farms in Finland. The average farm consisted of 31 ha (77 acres) of arable land and 46 ha (134 acres) of forest (Tike, 2010, p. 43). Farming remains a male-dominated occupation; 53,890 (66%) of the 81,146 farmers and family members (in 2009) with pension and workers' compensation insurance were male, and 27,256 (34%) were female (Mela, 2010). The mean age of

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farmers in Finland was 49 years of age in 2004, higher than all occupations (41) in Finland, but lower than the mean age (55 in 2007) of farm operators in the U.S. (Statistics Finland, 2004; USDA, 2010). Most farms in Finland remain family operated, with primary income from farming (Suutarinen, 2009; Tike, 2010, p. 46).

Occupational injury rates among farmers are high worldwide and in Finland as well (Goldcamp, 2010; Rautiainen et al., 2009; Solomon, 2002; McCurdy and Carroll, 2000). Mental stress and weakened work ability are growing health problems within the agricultural sector (Kallioniemi et al., 2008; Karttunen and Rautiainen, 2009). Preventive efforts have been implemented to reduce agricultural injuries and occupational diseases. However, there is little evidence that these efforts have been effective (Lehtola et al., 2008).

Several programs to improve farmers' health have been implemented in Finland, where self-employed farmers have mandatory pension and accident insurance schemes. Self-employed farmers are also encouraged to join the Farmers' Occupational Health Service (FOHS), which is typically arranged in municipal healthcare centers. In 2007, more than half of full-time farmers were covered by FOHS (Kinnunen et al., 2009).

In Finland, farmers' occupational health hazards, work-related diseases, and injuries have been studied as a part of the FOHS development program in a series of surveys in 1979, 1982, 1986, and 1992. In 1992, the work-related injury rate for full-time farmers was 15%: 19% for males and 12% for females (Taattola, 1994). In 2005, the follow-up survey assessed farmers' working conditions and occupational risks, perceived health, work ability, physical and mental work strain, and occupational and leisure time injuries (Rissanen, 2006). FOHS has had a positive impact on farmers' health and occupational safety (Hulshof et al., 1999).

Injuries often occur while farmers respond to an unexpected malfunction in machinery or an animal handling system. Therefore, it has been suggested that better business management could improve farm operations, reduce production disturbances and delays, and reduce the risk of injuries as well (Suutarinen, 2004). The quality of business management influences the functionality of production and safety. In order to reduce the frequency of injuries on farms, it is important to understand the association of injuries and contributing mechanisms, including farm management.

The objectives of this study were to quantify the frequency of occupational injuries among full-time farmers and to evaluate risk factors for injury, particularly those related to farm management, FOHS membership, and a recent farm walk-through survey conducted by FOHS personnel. This study analyzes data from a larger survey, "Occupational Health and Farming in Finland in 2004," which was carried out by the Finnish Institute of Occupational Health during 2004-2006 (Rissanen, 2006).

Materials and Methods

Subjects

The participants in the survey (Rissanen, 2006) were sampled randomly from the 72,000 active farms (Tike, 2010, p. 42) in the farm register of the Information Center of the Finnish Ministry of Agriculture and Forestry in 2004. The aim of the survey was to interview 1,000 full-time farmers and an unspecified number of part-time farmers. The final sample was 2,471 persons, of whom 1,968 were farmers (principal operators) and 503 were farmers' spouses (fig. 1).

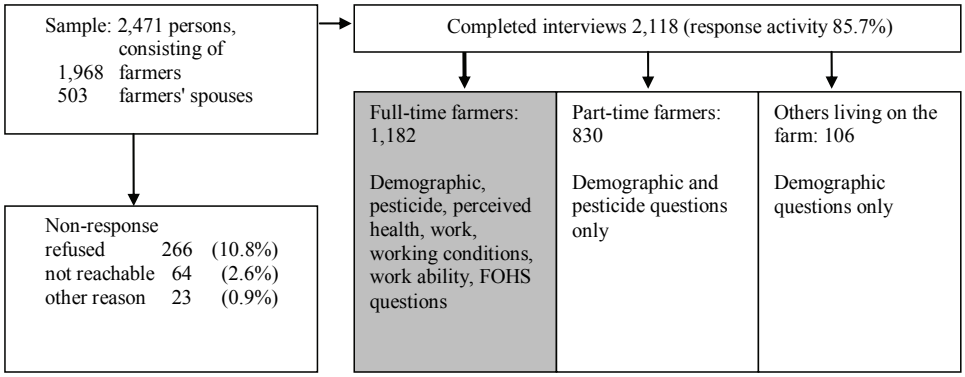

Figure 1. Sampling, response activity, and topics covered in the interviews.

Telephone interviews were carried out by the computer-assisted telephone interview (CATI) unit of the Finnish Institute of Occupational Health (FIOH) between November 2004 and February 2005. The CATI unit of FIOH has extensive experience in telephone interviews regarding work and health issues, enabling high quality in data collection and close supervision by the researchers.

The participants were informed about the study by mail before the interview. If there were two or more farmers on the farm, the interviewee was chosen randomly. The total number of completed interviews was 2,118, and the participation rate was 86% (Rissanen, 2006). A total of 1,182 of the interviewed farmers were self-employed full-time farmers aged 18 to 64 years. This subpopulation of the original survey was selected for our current injury analysis.

Over three-quarters of the study population were male, and less than a quarter were female (table 1). The mean age of the farmers was 46.9 years, and the mean area of the arable land was 44.2 ha, both similar to all active Finnish farmers in 2004 on average. The target population of our study was full-time farmers. Thus, farmers with animal production (63%) in general and dairy production (42%) in particular were over-represented in our study population compared to all active Finnish farmers in 2004 (Tike, 2010).

Variables in Injury Analyses

The questionnaire of the original survey consisted of 276 main questions and, with sub-questions included, a total of 704 variables (Rissanen, 2006). We selected management-related variables and other co-variates of interest for analysis evaluating the associations of injury and explanatory variables. These variables included:

- **Personal**: Gender, age, working years in farming, marital status, vocational agricultural education, membership in FOHS, and the time of the most recent farm walk-through.
- **Lifestyle**: Body mass index, use of alcohol, smoking habits, exercise.
- **Farm**: Arable land, forest area, type of production, farm work, using or doing contract work.
- **Injury hazards**: Rollover protection on tractors, tractor working hours per year, heavy lifting at work.
- **Health status**: Chronic illnesses, musculoskeletal disorders, perceived work ability.

Table 1. Demographic characteristics of the study subjects.

Variable	Category	Frequency	Percent
Gender	Male	911	77.1
	Female	271	22.9
Age	20-29	42	3.5
	30-39	234	19.8
	40-49	380	32.2
	50-59	442	37.4
	60+	84	7.1
Arable land (ha)	1-19	238	20.1
	20-29	242	20.5
	30-39	196	16.6
	40+	506	42.8
Primary production sector	Dairy cattle	492	41.6
	Other bovine cattle	89	7.5
	Pigs	101	8.5
	Other animals	58	4.9
	Cereal	309	26.1
	Other crop	98	8.3
	Forestry	35	3.0
Marital status	Single	203	17.1
	Divorced/widow	47	4.0
	Married/cohabitant	932	78.9
Education	No or some vocational education courses	446	37.7
	Vocational education	545	46.1
	College-level or university education	191	16.2

- **Mental well-being**: Mental strain at work, stress at present, depressive symptoms, other common mental symptoms.
- **Attitudes**: Perceived hazards (injury risk, noise, vibration, lighting, gases, dusts, mold, poisonous substances) in farm work, use of personal protective equipment in hazardous work (detergents, pesticide use, grinders).
- **Farm management**: Labor force on the farm, changes in type of production, existence of quality system on the farm, cooperation with other farmers, computer use in farm management, and future plans for farm production.

The dependent variable in our study was: "Have you experienced any occupational injuries in farm work needing medical consultation during the past 12 months" (Yes or No)? If Yes, the next question was: "How many such farm work injuries occurred to you during the past 12 months?" Further questions addressed the characteristics of the latest occupational injury: "In which work activity did the injury occur?", "How did this injury occur?", "Where did this injury occur?", "What kind of consequences followed?", "How long was your disability time period?", and "Was further treatment in hospital or a clinic required?"

Statistical Methods

We used the FREQ, CORR, and LOGISTICS procedures in SAS for Windows to process information (version 9.13, SAS Institute, Inc., Cary, N.C.). The dependent variable was the count of injuries, and therefore the statistical methods included Poisson regression. We analyzed the association of injury and variables of interest using STATA (version 10.0, StataCorp LP, College Station, Tex.) and calculated corresponding rate ratios obtained by Poisson regression modeling (McCullagh and Nelder, 1989). Multivariable regression models were constructed using stepwise, forward selection.

Results

Incidence of Occupational Injuries

Nearly every sixth (16 injuries/100 person-years) of the interviewed farmers (n = 1182) experienced occupational injuries requiring medical treatment within the past 12 months prior to the survey; 158 farmers had one injury, 24 farmers had two injuries, four farmers had three injuries, and one farmer had four injuries. The greatest number of injuries occurred on dairy farms, among both male and female farmers (table 2). Cereal crop production had the second highest number of injuries, and all but one occurred to males.

The total number of occupational injuries was 222. Injuries were more frequent among male farmers (n = 183; 17 injuries/100 person-years) than among female farmers (n = 39; 13 injuries/100 person-years) (table 3). Animal husbandry was the most common work activity during injury, involving 34% of the cases among males and 87% among females. Machine maintenance, field work, and construction work were common injurious work activities among males. The most common types of incidents for both genders included falling or slipping, being struck by objects, animal movements, and overexertion movements.

Farmers needed on average 2.6 medical consultations per injury. The average disability duration was 20 days for males and 29 days for females. Injuries that occurred in construction work or in handling or storing crops needed more medical consultations and lost work days compared to injuries in other types of work.

Table 2. Number of injured farmers by type of farming operation in a population of 1182 farmers (911 male and 271 female).

Farming operation	Male	Female	Total	Percent
Dairy	52	19	71	38.0
Cereal crops	50	1	51	6.9
Pigs	18	4	22	11.8
Other crops	11	1	12	6.9
Other animals	8	5	13	27.3
Other bovine	8	5	13	6.4
Forestry	5	0	5	2.7
Total number of injured farmers	152	35	187	100.0

Table 3. Number of injuries by type of work activity at the time of injury in a population of 1182 farmers (911 male and 271 female).

Work activity at the time of injury	Male	Female	Total	Percent
Animal husbandry	63	34	97	43.7
Maintenance/repair of machinery	29	0	29	13.1
Field work	19	0	19	8.6
Construction work	16	0	16	7.2
Coupling/decoupling of implements	14	0	14	6.3
Forestry work	13	2	15	6.8
Using of angle grinder	11	1	12	5.4
Tractor driving	7	0	7	3.1
Handling of crop	5	1	6	2.7
Other	6	1	7	3.1
Total number of injuries	183	39	222	100.0

Table 4. Risk factors for injury: Unadjusted and adjusted models (*n* = 1182 farmers).[a]

			Unadjusted			Adjusted		
			Rate	95% CL		Rate	95% CL	
Variable	Category	Freq.	Ratio	Lower	Upper	Ratio	Lower	Upper
Gender	Female (Ref.)	271	1	1	1	1	1	1
	Male	911	**1.40**	**1.00**	**2.01**	**1.40**	**1.00**	**2.01**
Age	20-29	42	1.99	0.82	4.87	2.10	0.86	5.13
	30-39	234	**1.97**	**1.05**	**4.11**	**1.91**	**1.01**	**4.00**
	40-49	380	1.69	0.92	3.48	1.49	0.81	3.10
	50-59	442	1.35	0.73	2.79	1.31	0.71	2.71
	60+ (Ref.)	84	1	1	1	1	1	1
Cooperation between farms[b]	No (Ref.)	515	1	1	1	1	1	1
	Yes	664	**1.65**	**1.25**	**2.20**	**1.57**	**1.18**	**2.10**
Computer use in farm management[c]	No (Ref.)	361	1	1	1	1	1	1
	Yes	821	**1.39**	**1.03**	**1.92**	1.13	0.83	1.578
Perceived injury risk[d]	No/small risk (Ref.)	984	1	1	1	1	1	1
	High risk	198	**1.68**	**1.23**	**2.26**	**1.65**	**1.20**	**2.24**
Perceived stress symptoms[e]	Not at all/ somewhat (Ref.)	1051	1	1	1	1	1	1
	A lot/very much	125	**2.15**	**1.53**	**2.95**	**1.96**	**1.39**	**2.73**

[a] Estimates are adjusted for gender, age, cooperation between farms, future plans in farm production, computer use in farm management, perceived injury risk, and perceived stress symptoms. Freq. = frequency, CL = confidence limits, and Ref. = reference group.

[b] "Do you cooperate with other farmers?"

[c] "Does anyone use a computer for farm management on your farm?"

[d] "How much does injury risk affect your work?"

[e] "By stress we mean a situation in which you feel excited, restless, nervous, or uneasy and may find it difficult to sleep because of constantly having things on your mind. Do you currently feel this kind of stress?"

Injury Risk Factors

Potential risk factors for injury were first evaluated in univariate Poisson regression models. Six variables were found significantly associated with injury, as presented in table 4. Out of these variables, multivariable Poisson regression with a stepwise (forward) model selection procedure identified the following risk factors for injury: male gender, younger age, cooperation between farms, high perceived accident risk, and high perceived stress symptoms. Table 4 provides estimates of the rate ratios, together with their 95% confidence limits, for the levels of each explanatory variable. The rate ratios need to be interpreted relative to the selected reference group. Significant rate ratios are presented in bold.

The results indicated that male farmers had higher risk of injury compared to female farmers; the rate ratio for males was 1.40 (1.00 to 2.01) in the adjusted model. Farmers between 30 and 39 years of age had significantly higher risk of injury compared to their peers over 60 years of age.

As for farm management related factors, cooperation between farms and computer use in farm management were included in the model. Cooperation between neighbors in farm work increased the injury risk in the unadjusted and adjusted models. Computer use in farm management was a significant risk factor in the unadjusted model only. Perceived injury risk and perceived stress symptoms were both significantly associated with higher injury risk in the adjusted model.

Discussion

The annual injury rate in this study was nearly three times higher than the rate based on insurance statistics from the Finnish Farmers' Social Insurance Institution (Mela, 2010): 16/100 and 6/100, respectively. Our study focused on full-time farmers, whereas the insurance statistics also include part-time farmers. Dairy farmers were especially over-represented in our study population. The results of our study are comparable to the earlier "Occupational Health and Farming in Finland in 1992" study (Taattola, 1994). Virtanen et al. (2003) also found that the injury rate among full-time farmers in general and livestock farmers in particular was higher than that of all farmers. However, data collection method, recall time, and injury definition are factors that influence the injury rate as well (Rautiainen et al., 2004). Based on his literature review, Suutarinen (2003) stated that injury rates are higher in epidemiological studies using interviews and questionnaires compared to official statistics of compensated injury claims.

In this study, we had a specific interest to evaluate the association of injury and management-related variables. Suutarinen (2004) has shown that management quality is associated with injuries. However, the effects of various aspects of management require further study. For instance, the demands to comply with various production quality systems have increased. They should have positive effects on safety since many quality systems include risk and safety management components. Therefore, several management status indicators were included in this study.

Several factors found significant in other studies were not significant in our data, including presence of dairy cattle (Rautiainen et al., 2009), presence of rollover protective structures (ROPS) on tractors (Day et al., 2009), or large field size (Rautiainen et al., 2009). In Finland, ROPS have been required on new tractors since 1969, and operating tractors without a proper cab is rare.

Male farmers had a higher injury percentage than female farmers (17% vs. 13%). Similar results have been reported in other studies (Virtanen et al., 2003; Simpson et al., 2004). Gender differences in injury rates follow the traditional division of work on family farms in Finland. According to Virtanen et al. (2003) and Rautiainen et al. (2009), male farmers work in the fields and do forestry work more often than their spouses. However, labor-intensive animal husbandry is usually shared quite evenly between the farming couple. Taking care for animals is an essential part of female farmers' daily work, and therefore injuries that occur in animal husbandry are most common among females (Taattola, 1994; Mela, 2010).

Farmers between 30 and 39 years of age had the highest injury risk. This result differs from the results of Virtanen et al. (2003) and Rautiainen et al. (2009), in which either younger or older farmers had the highest risk of injury. Both included full-time and part-time farmers. Our population includes only full-time farmers; within this group, farmers in their thirties may be under heavy financial burden and stress while expanding and reorganizing their production (Statistics Finland, 2009; Rantamaki-Lahtinen and Vare, 2011). Increased work hours and exhaustion are known to result in increased risk of injuries (Voaklander et al., 2009) and traffic accidents (Robb et al., 2008).

Cooperation between active Finnish farms is relatively common, and it has many examples, from neighbors helping and sharing machinery to joint purchases of farm inputs (Karttunen and Tuure, 2008). Farmers seek economic benefits from such cooperation. Furthermore, farmers state that cooperation improves work safety to some degree but not as much as hiring a contractor. Larger labor-intensive farms appear to gain most (Kart-

tunen and Tuure, 2008). In a Swedish case study, cooperating farmers pointed out that, in addition to economic benefits, cooperation decreases their vulnerability and risks (de Toro and Hansson, 2004).

Thus, we hypothesized that cooperation between farms should be associated with lower risk of injuries. On the contrary, cooperation was associated with higher injury risk in our study. Cooperation may indeed lead to higher risk of injuries in situations where farmers borrow machinery that they cannot operate properly. In such cases, malfunctions of machinery may increase the risk of injuries. However, the association of cooperation and injuries may be confounded by factors that we could not control, such as exposures on work-intensive cattle farms that were over-represented in our study.

Computers have become common tools on Finnish farms; in 2007, about 81% of the farms had a computer and 77% had an internet connection, broadband in most cases (Tike, 2010, p. 73). We hypothesized that computer use is a predictor of knowledge-intensive management, which reduces uncertainties in farming (Aakkula et al., 2002) and should be related to better management and thus to a lesser amount of disturbances and related injuries. However, in contrast to the hypothesis, computer use for farm management was related to higher injury risk, although only in the unadjusted model. This unexpected result could be explained by differences in work activity on computerized and non-computerized farms, for which we were not able to control. In particular, animal husbandry requires repetitious book-keeping, in which computers are commonly used. Computerized farms may be more modern and active, and hence the working hours and exposures to hazards may be greater. Further, active computerized farms may operate under higher levels of hurry and stress, despite the better tools for management, thus adding to the injury risk.

Rautiainen et al. (2004) reported that two-thirds of injuries in the Certified Safe Farm study were influenced by hurry, fatigue, and stress, which are related to the management and organization of work. According to Mattila et al. (2007), the most challenging management tasks and topics for farmers in Finland included the investment decision process and maintaining safety and health, along with the ability and motivation to work. They suggest that these are the main areas that should receive more attention in agricultural education curricula and extension initiatives. Based on these results, we should not judge computer use on farms and cooperation as risk factors for injuries.

The perceived accident risk was significantly associated with actual reported injuries. It is not known if the perceived accident risk was a direct result of an actual injury event. According to Saari (1990), employees need motivation to act safely, in addition to occupational health and safety information. According to Kidd et al. (1996), farmers believed that they had expert knowledge on most injury prevention strategies, and that lack of knowledge was not a key risk factor for injury.

Perceived stress symptoms were significantly associated with higher injury risk. According to Kallioniemi et al. (2009), one-third of the full-time farmers in Finland experience excessive stress. Stress in life has been reported as a significant risk factor for injuries in many studies (Xiang et al., 2000; Simpson et al., 2004; Rautiainen et al., 2004). Depressive symptoms and hours spent with animals were associated with an increased incidence of farm-work-related injury in a study by Park et al. (2001). Kidd et al. (1996) found that fatigue influenced both mental and physical aspects of work, and was an important risk factor in the farm environment.

According to Hulshof et al. (1999), FOHS has had a positive impact on farmers' health and occupational safety. However, in our study, membership in FOHS or a recent farm walk-through survey conducted by FOHS personnel was not associated with reported injury. In the future, it is important to improve the procedures of the farm walk-through, and to advise and motivate farmers in active injury prevention related to their working conditions and habits.

Strengths and Limitations of the Study

The strengths of this study include that it was based on a relatively large survey of 1,182 full-time farmers. The participation rate was very high (86%). The data included many variables not commonly available in injury studies. The interviews were conducted at the FIOH, and the interviewers were trained at the beginning of the study by the researchers, which is critical for the quality of the data.

Although the study population was quite large, injury is a relatively rare outcome, and the statistical power to detect significant associations was limited by the sample size. Our injury study was only one small part of the survey, and therefore the number of questions concerning injury and explanatory variables was limited.

It is also recognized that self-reporting of injuries in farm work during the past 12 months may involve potential recall biases, as reported by Lewis et al. (1998).

Conclusions and Recommendations

We conclude that the high annual injury rate among full-time farmers in general and cattle farmers in particular needs more attention. Interventions are needed among full-time farmers, particularly males, in their thirties. At this age, many farmers are under heavy financial burden and stress while establishing, expanding, and reorganizing their production. Farmers' Occupational Health Services (FOHS) are already commonly utilized by full-time farmers. FOHS should consider perceived high injury risk and stress symptoms as indicators emphasizing the need for injury prevention measures. The organization and management of farm work need further study regarding their role in farm injury causation and prevention. Based on this study, we recommend increased guidance, especially for beginning cattle farmers, addressing work organization skills and farm management skills.

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