Risk Factors for Animal-related Injury Among Iowa Large-livestock Farmers: A Case-control Study Nested in the Agricultural Health Study

Nancy L. Sprince, MD, MPH; Hyesook Park, MD, PhD; Craig Zwerling, MD, MPH, PhD; Charles F. Lynch, MD, PhD; Paul S. Whitten, MA; Kendall Thu, PhD; Leon F. Burmeister, PhD; Patricia P. Gillette, MPH; and Michael C. R. Alavanja, DrPH

ABSTRACT: ***Context:*** *Although farmers are at risk for injuries from contact with large livestock, few previous studies have examined risk factors for animal-related injuries.* ***Purpose:*** *This case-control study, nested in the Agricultural Health Study, aimed to assess risk factors for animal-related injury among Iowa large-livestock farmers.* ***Methods:*** *A screener questionnaire sent to 6999 farmers identified 116 farmers with large livestock who had an animal-related injury requiring medical advice/treatment in the previous year. Several possible risk factors for injury were assessed by comparing these farmers with 342 farmers who had livestock but were not injured in the previous year.* ***Findings:*** *A multiple logistic regression analysis showed significant associations between animal-related injury and the use of a hearing aid (odds ratio [OR] = 5.4 [95% CI, 1.6 to 18.0]), doctor-diagnosed arthritis or rheumatism (OR = 3.0 [95% CI, 1.7 to 5.2]), education beyond high school (OR = 1.8 [95% CI, 1.1 to 2.8]), and a younger age. Farmers engaged in off-farm work were less likely to sustain animal-related injuries (OR = 0.4 [95% CI, 0.2 to 0.8]).* ***Conclusions:*** *This is the first study to show associations between animal-related injury and a younger age, hearing difficulties, and doctor-diagnosed arthritis. Hearing loss and arthritis, which are more common among farmers than among other workers, may be particularly important risk factors to address in future preventive studies.*

Farming is recognized as one of the most hazardous occupations in the United States. Farmers face a death rate from work-related injuries that is more than 5 times that for U.S. workers in general.[1] Studies of injury-related morbidity among farmers have shown that animals, machinery, and falls are the chief sources of farm injury.[2-4] Recent reviews have noted that up to one third of injuries on the farm are caused by animals.[5,6] Thu et al[5] also noted that livestock-related injuries account for the highest rate of lost work days among farmers on the basis of the Traumatic Injury Surveillance of Farmers Survey.[7]

It is possible that risk factors for injuries caused by animals on the farm differ from those for farm injuries with other causes. The few studies that have addressed risk factors specific to animal-related farm injury[8,9] have involved dairy farmers in Wisconsin. To extend risk factor information to include other instances of animal exposure, we carried out a case-control study of risk factors for animal-related injury in Iowa, which ranks first in hog production in the United States.[10] The present study aimed to assess risk factors for animal-related injury among a large group of Iowa farmers who raise livestock.

Methods

This study is one of several injury case-control studies nested in an ongoing prospective cohort study, the Agricultural Health Study (AHS).[11] A description of the overall methods was presented in the first of these studies, which was an assessment of risk factors for injury events caused by acute, high exposures to pesticides.[12] Methods for the current case-control study of risk factors for animal-related injuries follow.

Identification of Cases and Controls. In November 1997, we sent screener questionnaires to 6999 randomly chosen private pesticide applicator participants in the AHS in Iowa (out of a total of 30 009 private pesticide

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applicator participants). The purpose was to identify injured farmers and uninjured farmer controls who could be asked to participate in the case-control study. To follow up nonrespondents, we repeated the screener mailing 2½ weeks after the first mailing and attempted telephone contact to administer the screening questionnaire 5 weeks later. A total of 6115 participants completed the screener questionnaire (response rate, 87.4%). Of these respondents, 5970 (97.6%) met the Census of Agriculture definition of *farmer* (reporting that their farms had had gross annual sales of agricultural goods of $1000 or more in the past 12 months).

Cases. Injured farmers were those who answered "yes" to both of the following questions: "During the past 12 months, were you injured seriously enough that you got medical advice or treatment?"[13] and "Was the injury in any way related to your farm operation (this includes activities such as farm-related transportation on roadways, or any other aspect of your farm, such as raising livestock animals for recreation or home use)."[14] Injured farmers eligible for the present study were further limited to those who reported that the farm they owned or worked on had hogs, cattle, horses, or sheep. We considered an injury animal-related if the primary or secondary source was coded as large livestock, including hogs, cattle, horses, or sheep, or if the farmer's description of the injury revealed that the farmer was feeding or tending these large livestock at the time of injury.

Controls. We randomly selected controls from among farmers responding to the screening questionnaire who reported no injury requiring medical advice or treatment in the preceding 12 months. Controls eligible for the present study were further limited to those who reported that the farm they owned or worked on had hogs, cattle, horses, or sheep. Those with a nonfarm-related injury (n = 133) were ineligible to become case or control subjects in this study, since the focus of the study was on farm-related injuries.

Computer-assisted telephone interviews of cases and controls were carried out from February to July 1998 by trained interviewers. On the basis of responses to the screener questionnaire, which were confirmed at the outset of each telephone interview, there were 521 eligible injury case subjects and 603 eligible control subjects. All eligible subjects received $10 if they completed the telephone interview. After 8 unsuccessful calling attempts, including attempts made on evenings and weekends, a subject was considered a nonrespondent. Of the 521 eligible case subjects, 431 (82.7%) were interviewed successfully. Of the 603 eligible and selected control subjects, 473 (78.4%) were interviewed successfully. One hundred sixteen of the interviewed case subjects were large-livestock farmers who reported an animal-related injury in the past year, and 342 of the interviewed controls were large-livestock farmers who reported no injury in the past year. This report is based on responses from these 116 cases and 342 controls.

Data Collection and Coding. Data on injury outcome and those on risk factors for injury were derived from the same questionnaire covering the preceding 12-month period. The questionnaire included sections for the following 9 categories: personal demographics; work history and workload characteristics, including work on and off the farm and help with farmwork provided by a spouse or other person; personal medical history; depression, stress, and sleepiness; alcohol consumption and cigarette smoking history; attitude toward risk; safety training history; farm finances; and farm products.

For the outcome variable, animal-related injury, the questionnaire asked about the following characteristics of each animal-related injury: major body part injured, major type of injury, description of event and source associated with the injury, and duration of any resulting hospitalization. We used the Bureau of Labor Statistics Occupational Injury and Illness Classification manual[15] to code all injury characteristics: nature, part of body affected, source, and event/exposure related to injury. One investigator (K.T.) coded all the injuries, and two additional investigators (N.L.S. and C.Z.) reviewed the initial coding. The original coding was revised only when both secondary coders agreed on a change in coding.

Questions on current medical conditions (eyesight and hearing; use of glasses, contact lenses, and hearing aids; doctor-diagnosed arthritis/rheumatism, depression, heart disease, and asthma) from the Health and Retirement Survey questionnaire[16] and the National Health Interview Survey on Disability[17] were used. Other questions in this section covered presence and types of disabling impairments or health conditions, and regular medication usage (at least 1 day per week during most weeks or for 3 months or more in the past year, excluding medications taken for injuries).

The abbreviated 11-item CES-D Depression Scale (assessing symptoms over the last week)[18,19] and the 4-item Perceived Stress Scale (assessing symptoms over the last month)[20] with an added fifth question concerning changes in stress level over the last year were used to assess mood and stress. The Epworth Sleepiness Scale (no time frame mentioned)[21] was used to assess daytime somnolence that may be associated with injury. This standardized scale includes 8 questions assessing the likelihood of falling asleep during various common daytime activities.

We assessed alcohol use with the CAGE questions

("Have you ever felt you should **C**ut down on your drinking?" "Have people ever **A**nnoyed you by criticizing your drinking?" "Have you ever felt bad or **G**uilty about drinking?" "Have you ever taken a drink first thing in the morning (**E**ye-opener) to steady your nerves or get rid of a hangover?").[22] Each CAGE question response was "yes" or "no," where "yes" was the response associated with a greater likelihood of alcoholism. We considered 3 or 4 "yes" responses a high CAGE score.[23] In addition, we asked about current alcohol use and the current amount of alcohol consumed. We used cigarette-smoking questions and categories from the Third National Health and Nutrition Examination Survey.[24] Current smokers were defined as people reporting cigarette smoking at the time of the study; ex-smokers were people who had smoked at least 100 cigarettes in their lifetime but reported that they had stopped smoking by the time of the study.

We assessed respondents' attitudes toward risk on the basis of their agreement with the following statements[25] (no time frame specified): (1) "Farming is more dangerous than jobs in industry or manufacturing"; (2) "Accidents are just one of the occupational hazards of farming that must be accepted if you are going to be in the business"; (3) "Compared to other farmers I am very conscientious about avoiding accidents"; (4) "During a normal work week, it's common for me, while doing farm work, to experience a number of 'close calls' that under different circumstances might have resulted in personal injury or property loss"; and (5) "To make a profit, most farmers take risks that might endanger their health." We counted an answer of "disagrees" as a 0 for questions 1, 2, 4, and 5 and an answer of "agrees" as a 1. We counted agreement with question 3 as a 0, and disagreement was counted as a 1. Subjects with cumulative scores of 0 to 2 were considered "risk averse," and subjects with scores of 3 to 5 were considered "risk accepting."[12]

The safety training section included questions on the source, date, and duration of training in any organized farm safety program or course. These questions covered any safety program, not just injury prevention training. The section on farm finances and products included questions (covering the preceding 12 months) on the number of acres farmed, current farm debt as a percentage of farm assets, types of crops or livestock raised on the farm, and the farmer's self-assessment of the current financial condition of the farm.

We scored the responses concerning stress, depression, and sleepiness according to standard scales and dichotomized the scales into high- and low-exposure categories. We defined high stress scores and high sleepiness scores as those in the upper quartile of the observed scores. A high depression score was >16 on a scale of 11 to 33 (the upper 10% of the scores[26]). The Institutional Review Board on human subjects at the University of Iowa reviewed and approved the study.

Statistical Methods. The unit of analysis was the individual injured livestock farmer, regardless of the number of injuries the farmer reported. SAS 6.12 was used to complete the analyses. Continuous demographic variables (age, years of farming experience) were compared by Student's t test. The independent variables of interest were questionnaire responses to the 9 risk factor categories described above. We performed bivariate analyses to assess the association between each independent variable and the dependent variable, animal-related injury in the previous year. We used the Higgins and Koch[27] method for variable selection to build a logistic regression model. For this procedure, we included all independent variables except those we thought were likely to have resulted from an injury in the past year (depression, stress, and attitude toward risk). We assessed the strength of association between these independent variables and animal-related injury by calculating the Mantel-Haenszel[28] χ^2. We then selected the variable with the largest χ^2, significant at $P \leq .05$, stratified by that variable, and reanalyzed the remaining variables. We repeated this procedure until no further independent variables were significant at $P \leq .05$. The resulting model was considered the base (final) model (shown in Table 4). We then entered the chosen variables into a multivariable logistic regression model using forward selection. We compared the results of that model with those of a backward elimination model and found no differences in the variables remaining in the base model. We assessed the goodness of fit of the resulting model.[29] The dependent variable used was livestock farmer with animal-related injury (case) versus livestock farmer with no injury (control), as defined above. To the base model, we then added, one-by-one, the variables that could have resulted from the injury (depression, stress, and attitude toward risk variables) to assess their associations with animal-related injury, adjusting for the variables in the base model. The rationale was that these 3 variables (depression, stress, and attitude toward risk) are considered predictors of injury. However, since they could have resulted from the injury rather than preceded it, they were tested in the model only after all other predictors had been included or excluded.

Results

We found 116 livestock farmers who reported at least 1 animal-related injury over the previous year and 342 livestock farmers who reported no injury over the

Table 1. Characteristics of the 124 Animal-related Injuries Among 116 Farmers With Animal-related Injury in the Preceding 12 Months in Iowa, 1997

Characteristic	No. of Injuries	% of Total Injuries
Nature of injury		
Sprains, strains, tears	33	26.6
Fractures	26	21.0
Cuts, lacerations	22	17.7
Bruises, contusions	17	13.7
Dislocations	12	9.7
Other* or unspecified	14	11.3
Part of body injured		
Lumbar region or back	26	21.0
Hands, except fingers	13	10.5
Finger	13	10.5
Knees	11	8.9
Chest, external	9	7.3
Other* or unspecified	52	41.8
Animal source of injury		
Cattle	70	56.5
Hogs	35	28.2
Horses	7	5.6
Sheep	2	1.6
Unspecified livestock	10	8.1
Event causing injury		
Assault by animal	59	47.6
Fall to floor/ground	10	8.1
Overexertion/lifting	9	7.3
Other* or unspecified	46	37.0

* All remaining categories, each of which accounted for fewer than 6% of injuries.

previous year. The 116 case subjects sustained a total of 124 animal-related injuries, with 8 farmers reporting 2 injuries and 108 farmers reporting 1 injury in the preceding year. Eleven farmers sustained animal-related injuries that required hospitalization. For the 124 injuries sustained by the 116 livestock farmers, Table 1 shows the nature of the injury, the part of the body injured, the animal source, and the event leading to the injury. When we compared injuries caused by hogs (n = 35) with injuries caused by cattle (n = 70), we found no significant differences with regard to the part of body injured or the proportion of injuries that required hospitalization (2/35 versus 8/70, $P = .42$). However, we did find differences with regard to the nature of the injury and the event leading to the injury, as shown in Table 2.

We found no significant differences in mean age (37.9 ± 27.6 versus 40.2 ± 23.6; $P = .43$) or years of farming experience (28.3 ± 13.4 versus 28.0 ± 11.4; $P = .83$) between cases and controls. We found no significant differences in percentages of case subjects and control subjects who raised cattle only (44% versus 42%), hogs only (21% versus 26%), or both cattle and hogs (35% versus 32%). When we compared demographic features of farmers by type of large livestock (cattle only, hogs only, and both cattle and hogs), we found no significant differences in years of farming, full-time versus part-time work on the farm, debt/asset ratio, weeks worked per year, or farm size. We did find significant differences in age (42 ± 24 years for cattle farmers, 38 ± 24 years for hog farmers, and 36 ± 26 for farmers who raised both cattle and hogs; $P = .03$) and in hours worked per week (50 ± 19 hours for cattle farmers, 51 ± 14 hours for hog farmers, and 58 ± 17 hours for farmers who raised both cattle and hogs; $P = .001$).

Cases and controls were comparable in all areas except for those found to be significant in bivariate analysis adjusted for age (Table 3). The following risk factors were significantly associated with animal-related injury in bivariate analysis: help from people other than a spouse on the farm for 12 weeks or more in the past year; the wearing of a hearing aid; difficulty hearing normal conversation even with a hearing aid; doctor-diagnosed arthritis or rheumatism; doctor-diagnosed asthma; and the taking of medications regularly. Subjects working off the farm, spending 12 or more weeks working off the farm in the preceding year, and having less than 25 years of farming experience were less likely to sustain animal-related injuries.

In the multivariable analysis (Table 4), doctor-diagnosed arthritis, the wearing of a hearing aid, and 12 or more weeks of off-farm work in the preceding year remained significantly associated with animal-related injury. The other variables that were significantly associated with animal-related injury in bivariate analysis did not remain significantly associated with animal-related injury and therefore do not appear in the final model. Additional variables that were significant in the final model were an age between 40 and 64 years (associated with decreased risk of injury) and more education (associated with an increased risk of injury). A Hosmer and Lemeshow goodness-of-fit test[29] resulted in a P value of 0.15, indicating an adequate fit for this model. When we entered the following interactions into the base model, we found that none were significantly associated with injury: age/doctor-diagnosed arthritis, age/use of hearing aid, and use of hearing aid/doctor-diagnosed arthritis. When we examined the risk factors that might result from injury (depression, stress, and attitude toward risk) by adding them individually to the logistic regression base model that included all of the

variables in the base model (Table 4), we found that depression, stress, and attitude toward risk were not significantly associated with animal-related injury.

Discussion

The major results of this study show that animal-related injuries on the farm are significantly associated with a younger age, doctor-diagnosed arthritis, use of a hearing aid, and education beyond high school. Off-farm work was associated with a decreased risk of animal-related injury. Few other authors have assessed risk factors for animal-related injury on the farm.[8,9] In a case-control study comparing 83 injured dairy cattle farmers with 152 noninjured dairy cattle farmers, Boyle et al[8] found significant associations between injury and treatment and trimming of hooves, hours per week spent in milking activities, and cleaning of barns 11 to 20 hours per week. In another case-control study involving the comparison of 70 case dairy farmers with 183 control dairy farmers, Layde et al[9] found that only the number of hours worked per week was significantly associated with animal-related injuries. Our study differed from those of Boyle et al[8] and Layde et al[9] with regard to gender distribution and types of large livestock raised. Over 40% of the subjects in both of those studies were women, compared with 1% of our subjects. Therefore, our study cannot be used to assess gender differences in animal-related injuries. The studies of Boyle et al and Layde et al focused on injuries primarily among dairy cattle farmers, while ours included both cattle and hog farmers. Unlike the study of Boyle et al., our study did not assess specific animal-related tasks (such as trimming hooves) as risk factors for injury. The length of our questionnaire was limited by considerations of time burden on the Agricultural Health Study subjects and the multiplicity of injury subgroups (including animals, machinery, high pesticide exposure, and other injuries) our questionnaire was designed to address.

Few studies have examined arthritis or joint symptoms as a risk factor for farmwork-related injury.[30-32] Only one of the studies that have examined these risk factors[32] found a significant association between joint symptoms and farmwork-related injury. Hwang et al[32] found that the odds of sustaining a farmwork-related injury for farmers who reported joint symptoms in the preceding year were 2.56 times those for farmers who did not report these symptoms. To our knowledge, ours is the first study to show an association between arthritis and the subgroup of injuries caused by animals. A possible explanation for our results is that arthritis limits lower- or upper-extremity mobility, which leads to injury through impaired ability to control or avoid large livestock. However, subjects who have recently been injured may be more likely to recall and report doctor-diagnosed arthritis than uninjured controls are. Directionality of causation may not be a major concern, since arthritis is more likely to be a chronic disease than a disease that results from an injury sustained in the preceding year. Other occupational groups may also be at increased risk for injury owing to arthritis. A previous study involving nonfarming workers with disabilities[33] showed a significant association between arthritis and occupational injury (odds ratio = 1.34 [95% CI, 1.07 to 1.68]).

Table 2. Characteristics of the 70 Cattle Injuries and 35 Hog Injuries in the Preceding 12 Months in Iowa, 1997

	No. (%) of Cattle Injuries	No. (%) of Hog Injuries	*P*
Nature of injury			.02 (5 df)
Sprains, strains, tears	13 (18.6)	11 (31.4)	
Fractures	15 (21.4)	6 (17.1)	
Cuts, lacerations	11 (15.7)	11 (31.4)	
Bruises, contusions	15 (21.4)	0	
Dislocations	6 (8.5)	4 (11.4)	
Other	10 (14.3)	3 (8.6)	
Event causing injury			.003 (3 df)
Assault by animal	44 (63.8)	12 (34.3)	
Fall to floor, walkway, or other surface	7 (10.1)	1 (2.9)	
Overexertion in lifting	2 (2.9)	5 (14.3)	
Other	17 (24.2)	17 (48.5)	

With regard to the use of a hearing aid as a risk factor for injury, we believe that our result should be interpreted with caution because of the small numbers of subjects with hearing impairments and the resulting wide confidence interval around the odds ratio. Because of the small numbers, we repeated the analysis with the use of LogXact 4 (Cytel), which is designed to assess variables of small size or unbalanced distribution in logistic regression analysis. We found that the LogXact estimation for "wears hearing aid" confirmed the results shown in Table 4.

Several studies have linked hearing impairment with occupational injuries among nonfarming working populations.[33-36] Of the several studies that have assessed associations between hearing impairment and farmwork-related injury,[30-32,37-39] only one has found a significant association.[32] To our knowledge, our study is the first to show an association between the specific subgroup of animal-related injury and hearing difficulty. It is possible that an inability to hear warning noises indicating changes in animal activity may have led to

Table 3. Bivariate Age-adjusted Associations of Risk Factors With Animal-related Injury in the Preceding 12 Months in Iowa (116 Cases Compared With 342 Controls, All Working With Large Animals on the Farm, 1997)*

	Cases		Controls			
Variable/Risk Factor†	Risk factor present	Risk factor absent	Risk factor present	Risk factor absent	Odds Ratio‡	95% CI
Demographic features						
Male	114	2	338	4	0.67	0.11–4.31
>High school education	60	56	146	196	1.44	0.94–2.20
Not married	11	105	34	308	0.88	0.42–1.84
Principal operator	107	9	305	37	1.72	0.79–3.75
Lives on farm	107	9	320	22	0.81	0.35–1.85
Had safety training prior to any injury	40	75	132	210	0.81	0.51–1.26
Farmwork experience ≤25 y	51	65	156	186	**0.51**	**0.27–0.95**
Personal habits						
Current smoker	7	109	31	311	0.64	0.28–1.48
Ex-smoker	37	79	81	261	1.60	1.00–2.55
Drinks alcohol currently	90	26	254	88	1.10	0.66–1.83
Has 2 or more drinks per day	24	66	56	198	1.15	0.65–2.05
CAGE§ score high	4	101	8	296	1.33	0.39–4.50
Farming factors						
Farm size small (≤500 acres)	62	53	169	169	1.20	0.78–1.83
Debt/asset ratio ≥10%	68	47	206	126	0.83	0.54–1.29
Self-reported financial condition poor/fair	27	89	76	266	1.07	0.65–1.78
Workload factors						
Worked ≥50 wk on farm in past year	103	13	287	54	1.46	0.77–2.78
Worked ≥50 h/wk on farm in past year	77	39	204	133	1.25	0.80–1.95
Spouse helped ≥8 wk on farm in past year	64	52	183	159	1.06	0.69–1.62
Others helped ≥12 wk on farm in past year	73	43	176	164	**1.59**	**1.03–2.45**
Worked part-time on farm in past year	4	112	28	314	0.40	0.14–1.14
Had job off farm past year	25	91	107	233	**0.59**	**0.36–0.97**
Worked ≥12 wk off farm in past year	14	102	78	262	**0.46**	**0.25–0.84**
Medical conditions						
Wears eyeglasses	81	35	222	120	1.62	0.97–2.73
Self-reported vision poor/fair	4	112	25	317	0.49	0.17–1.41
Wears hearing aid	10	106	5	337	**7.58**	**2.89–19.88**
Self-reported hearing poor/fair	28	88	69	272	1.32	0.80–2.20
Difficulty hearing normal conversation with hearing aid	40	76	79	262	**1.79**	**1.13–2.83**
Doctor-diagnosed arthritis/rheumatism	38	77	48	291	**3.53**	**2.14–5.81**
Doctor-diagnosed depression	9	105	21	319	1.41	0.63–3.16
Depression score high	16	97	28	312	1.87	0.97–3.62
Doctor-diagnosed heart disease	14	102	28	313	1.80	0.90–3.59

Table 3. *Continued*

Variable/Risk Factor†	Cases: Risk factor present	Cases: Risk factor absent	Controls: Risk factor present	Controls: Risk factor absent	Odds Ratio‡	95% CI
Doctor-diagnosed asthma	12	104	16	325	**2.46**	**1.15–5.25**
Preexisting disability	28	86	61	281	1.57	0.94–2.62
Sleepiness score high	62	54	161	181	1.33	0.87–2.02
Takes medications regularly	46	70	98	244	**2.07**	**1.29–3.33**
Risk attitudes and stress						
Risk acceptance score high	17	78	49	228	1.02	0.56–1.87
Stress score high	29	87	60	282	1.50	0.91–2.48

* Case and control totals in the table do not always sum to 116 and 342, respectively, owing to missing data.
† Variables in boldface type are those for which the 95% CI does not contain 1.0.
‡ Age-adjusted odds ratio.
§ CAGE is an acronym for an alcohol screening test: "Have you ever felt you should **C**ut down on your drinking?"; "Have people ever **A**nnoyed you by criticizing your drinking?"; "Have you ever felt bad or **G**uilty about your drinking?"; "Have you ever taken a drink first thing in the morning (**E**ye-opener) to steady your nerves or get rid of a hangover?"

our observed increase in animal-related injury risk among subjects with hearing aids. On the other hand, hearing impairment may act as a surrogate for duration and/or intensity of exposure for subjects working in the presence of noisy animals. Future studies should be done to address the causal pathways of the association between hearing impairment and injury.

Higher education is not likely a direct risk factor for animal-related injury. A possible explanation for the association found here is that subjects with more education recall and report injuries more thoroughly than others do. Both a younger age and higher education were significant risk factors for animal-related injury in our study. Our data show that younger farmers had significantly more education than did older farmers (results not shown). When age was controlled for, education remained significantly associated with animal-related injury.

While older age is a risk factor for fatal farm injury, younger age has emerged as a risk factor for nonfatal farm injury in several studies,[4,31] which is consistent with our findings. Lack of experience, pace of work, and other factors may contribute to this frequently observed association. It is also possible that younger farmers recall and report injuries better than older farmers do.

Our finding that 12 or more weeks per year of off-farm work is associated with a decreased risk of large-livestock–related injury is of interest. The distribution of farm tasks may vary with work time spent off the farm. It is likely that for those who work off the farm, time spent in contact with animals on the farm is decreased. Our data show that farmers who work off the farm work fewer weeks per year and fewer hours per week on the farm in general (results not shown), but we do not have data on the amount of time farmers spent specifically in contact with large livestock. An increase in work hours spent in contact with large livestock would be expected to increase the risk of large-livestock–related injury.

Because of the importance of exposure time as a risk factor for injury, we repeated the analysis, forcing in the exposure time measures we obtained, namely, hours per week and weeks per year spent in farming. We found no differences in the variables remaining in the final model shown in Table 4 and no significant relationship between our measures of exposure time and farm animal–related injury. A possible explanation for this finding is that our exposure time measurement was not specific to time spent in contact with large livestock.

Depression, sleepiness, and stress were not associated with animal-related injury in our study. Our results, showing no association between depression and farm animal–related injury, differ from those of Park et al[39] and Zwerling et al,[37] which showed significant associations between overall farmwork-related injury and depression. A possible explanation for this difference in results is that the outcome variables differed (overall farm injury in the studies of Park et al and Zwerling et al versus the subgroup of animal-related injury in the present study). Support for the hypothesis that sleep abnormalities may be associated with an increased risk of farm animal–related injury comes from

Table 4. Multiple Logistic Regression Analysis of Risk Factors for Farm Animal–related Injury Among 116 Injured Farmers Compared With 342 Uninjured Farmers, All Working With Large Animals on the Farm, in the Preceding 12 months in Iowa, 1997

Independent Variable	Odds Ratio*	95% CI
Wears hearing aid	5.35	1.59–18.0
Doctor-diagnosed arthritis/rheumatism	3.00	1.71–5.24
Education >high school	1.79	1.12–2.84
Age		
22–39 y	1.00	Reference category
40–64 y	0.44	0.26–0.72
≥65 y	0.61	0.27–1.34
≥12 wk of off-farm work in preceding year	0.42	0.22–0.80

* Each odds ratio has been adjusted for all other independent variables in the table.

a study showing an association between sleep-disordered breathing and motor vehicle crashes.[40] Another study showed an association between tiredness while farming and a history of farmwork-related injury.[41] Our results did not support an association between reported sleepiness (as measured by a standard sleepiness scale) and farm animal–related injury. To our knowledge, other studies have not addressed the association between results of a standardized sleepiness scale and farmwork-related injury. Results of a previous study suggested associations between stress and farmwork-related injury.[42] Our results did not support such an association. Differences in the measures of stress and in the outcome variables may account for the difference in results.

Risk factors associated with animal-related injury differed from those associated with high pesticide exposure events reported in another case-control study nested in this same cohort.[12] In that previous study, a poor financial condition on the farm and a tendency toward risk acceptance were significantly associated with a subject's having experienced a high incident exposure to pesticides in the preceding year. Such differences are not unexpected given that the outcomes assessed (agricultural chemical exposure and animal-related injury) differ in nature and in their causal pathways from exposure to outcome.

Our results agree with those of the Traumatic Injury Surveillance of Farmers Survey[7] and with those of Layde et al[9] in terms of similar distributions with regard to the nature of injury (sprains/strains, fractures, and lacerations).

Limitations of the present study should be taken into account when interpreting its results. The way in which injured subjects recall and report risk factors may be different from the way in which uninjured subjects do. In addition, these results are based on self-report of injury, with no validation from health care providers or hospitals. It is possible that animal injuries were underreported, since our questionnaire did not probe for injuries specifically related to animals, but relied on the subject's free-text description to categorize each reported injury. These results may not be generalizable to all Iowa farmers. Participants in this study came from the Agricultural Health Study, whose participants are about 5 years younger, more likely to work on larger farms, and somewhat more likely to raise large livestock than Iowa farmers.[10,43] The temporal relationship between injury and some risk factors cannot be determined with certainty in a case-control study. Our approach to minimizing this uncertainty was to analyze risk factors likely to result from an injury separate from those likely to precede the injury.

The strengths of this study include the relatively large number of injured subjects, which allowed the assessment of a large number of potential risk factors. In addition, our unique study group, comprising farmers heavily involved in hog production, adds to the previous body of knowledge on risk factors for animal-related injuries, which has been focused on cattle farmers' injuries. High response rates help to assure the generalizability of the results to the screened participants.

This is the first study to show associations between animal-related injury and the risk factors of younger age, hearing difficulties, and doctor-diagnosed arthritis. Hearing loss and arthritis may be particularly important risk factors to address in future preventive studies, since these conditions have been reported to be more common among farmers than among other workers.[44]

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