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Risk Factors for Falls Among Iowa Farmers: A Case-Control Study Nested in the Agricultural Health Study

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Background *Farmers are at increased risk for fall-related injury compared with other occupations. Little is known about risk factors for non-fatal falls on the farm. This case-control study, nested within the Agricultural Health Study, aimed to assess risk factors for work-related falls among Iowa farmers.*

Methods *A screener questionnaire sent to 6,999 farmers in 1998 identified 79 farmers who reported a fall-related farm injury that required medical advice or treatment in the previous year. Multivariable logistic regression analysis was used to assess several possible risk factors for injury among these farmers compared with 473 farmers with no injury in the previous year.*

Results *There were significant associations between fall-related farm injury and age between 40 and 64 years (OR = 2.21; 95% CI = 1.20–4.07), doctor-diagnosed arthritis/rheumatism (OR = 2.05; 95% CI = 1.11–3.79), difficulty hearing normal conversation (even with a hearing aid, in the case of those who used one) (OR = 1.82; 95% CI = 1.07–3.08), and taking medications regularly (OR = 1.80; 95% CI = 1.02–3.18).*

Conclusions *Aging and health impairments, such as arthritis and hearing difficulties, are risk factors for which accommodations and preventive strategies can be devised to prevent fall-related injuries on the farm.* Am. J. Ind. Med. 44:265–272, 2003.

KEY WORDS: falls; injury; agricultural; farmer; farming; risk factors; fractures

INTRODUCTION

Falls are an important cause of death due to injury, ranking first as the cause of injury death in those 65 and older. The direct cost of fall-related injuries is high, estimated at $20.2 billion in 1994, with a projected direct cost of $32.4 billion by 2020 [Centers for Disease Control, 2003]. Falls are also an important cause of occupational injury among farmers. In 2000, falls accounted for 18% of all non-fatal injuries and illnesses reported by the Bureau of Labor Statistics [U.S. Department of Labor, 2002] among workers employed in agriculture (including forestry and fishing) compared with 5% among all workers. According to results from the National Traumatic Injury Surveillance Project, falls accounted for 21% of the estimated 193,977 agricultural injuries (non-fatal, involving lost work time) in the

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United States in 1995 [NIOSH, 2001]. In a review of studies addressing agricultural injury in North America, McCurdy and Carroll [2000] reported a similar proportion of injuries, 25%, due to falls.

To our knowledge, only one previous case-control study assessed risk factors for non-fatal fall injuries among farmers [Nordstrom et al., 1996]. That study found that risk of fall injuries increased with increasing hours worked and for those who farmed with non-resident workers. That study also reported a protective effect from having registered cows on the farm.

The present study is a subgroup analysis of fall-related injuries, which was part of a larger case-control study of non-fatal agricultural injuries among farmers in Iowa [Sprince et al., 2003a]. The larger case-control study also assessed risk factors for the other major subgroups of injury, including acute pesticide exposures [Alavanja et al., 2001], animal-related injury [Sprince et al., 2003b], and machinery-related injury [Sprince et al., 2002]. The aim of the present study was to assess risk factors for non-fatal fall-related injuries among Iowa farmers. Risk factors for evaluation in this study were chosen based on *a priori* hypotheses and relevant literature suggesting that demographic features [Pratt et al., 1992; Zhou and Roseman, 1994; Nordstrom et al., 1996; Lyman et al., 1999], prior safety training [Lewis et al., 1998], personal habits [Zhou and Roseman, 1994; Lyman et al., 1999], farming factors [Brison and Pickett, 1992; Pratt et al., 1992; Zhou and Roseman, 1994], debt: asset ratio on the farm [Geller et al., 1990], workload factors [Pratt et al., 1992; Zhou and Roseman, 1994; Nordstrom et al., 1995; Thu et al., 1997], medical conditions [Browning et al., 1998; Hwang et al., 2001], risk beliefs [Harrell, 1995; Hodne et al., 1999], and stress [Thu et al., 1997] are all potential risk factors for farm injury.

METHODS

The methods for the case-control study have been described in detail [Alavanja et al., 2001; Sprince et al., 2003a]. In brief, a case-control study to examine risk factors for falls was nested in the Agricultural Health Study (AHS) [Alavanja et al., 1996]. Among the 30,009 Iowa participants in the AHS, a mail survey with telephone follow-up was completed, contacting 6,999 randomly chosen AHS participants (response rate 87.4%) in order to identify farmers (respondents whose farms had a gross annual sales of $1,000 or more of agricultural goods in the past year) who had sustained an agricultural injury in the prior 12-month period. Farmers who had sustained agricultural injuries were defined as those who answered ''yes'' to both of the following: ''During the past 12 months, were you injured seriously enough that you got medical advice or treatment?'' [National Health Interview Survey, Section II, Injuries, 1996] 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)?'' [Gerberich et al., 1993].

For this analysis, the cases were limited to those who had sustained a fall-related farm injury according to the Occupational Injury and Illness Classification system [U.S. Department of Labor, 1992]. From the 431 cases of any farm work-related injury in the past 12 months (response rate 82.7%), we found 79 cases with fall-related farm injuries and compared them to 473 randomly selected non-injured farmer controls (response rate 78.4%) we had also identified through the mail/telephone screening. Controls had to meet the farmer criteria defined above and had to have responded ''no'' to the question ''During the past 12 months, were you injured seriously enough that you got medical advice or treatment?'' Trained interviewers used a computer-assisted telephone interview method to administer a single questionnaire covering the same 12-month time interval for both the injury outcome and the nine categories of risk factors described below.

For the injury outcome, data were collected and coded for nature of injury, type of injury, source of injury, and event related to the injury [U.S. Department of Labor, 1992]. Coding was carried out by one of the investigators and then reviewed by two of the other investigators. The original coding was to be changed only if both reviewers agreed to the change. However, none of the cases required a change in the original coding. In addition, data were collected on need for hospitalization due to the injury.

From the same questionnaire, risk factor data were collected in the following nine categories which are described in detail below: (1) personal demographics; (2) work history and workload characteristics, including work on and off the farm, and help with farmwork from spouse or other; (3) medical conditions; (4) depression, stress, and sleepiness; (5) alcohol consumption and cigarette smoking history; (6) attitudes toward risk; (7) safety training history; (8) farm finances; (9) and farm products.

Data were collected on medical conditions (eyesight and hearing; use of glasses, contact lenses, and hearing aids; doctor ever-diagnosed arthritis/rheumatism, depression, heart disease, and asthma), using questions derived from the Health and Retirement Study (HRS) [1992] and the National Health Interview Survey on Disability (NHIS-D), Phase I questionnaire [1994]. Other questions on medical conditions included presence and type 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).

To assess mood and stress, the questionnaire included the Abbreviated 11-item CES-D Depression Scale, (assessing symptoms over the last week) [Radloff, 1977; Kohout et al.,

1993] and the four-item perceived stress scale (assessing symptoms over the last month) [Cohen et al., 1983] with an added fifth question concerning changes in stress level over the last year. To assess daytime somnolence that may be related to injury, the Epworth Sleepiness Scale (no time-frame mentioned) [Johns, 1991] was used. This scale uses eight questions addressing the likelihood that the subject would fall asleep during various common daytime activities.

For stress, depression, and sleepiness, the responses were scored using standard scales and the results were dichotomized into high and low exposure categories. High stress and sleepiness scores were categorized as those in the upper quartile of the observed scores. In the absence of standardized cut-points for high and low, the upper quartiles were chosen to ensure adequate power and differentiation of scores. A high depression score was in the upper 10% of the observed scores [Scarth et al., 2000].

To assess problems with alcohol use, the questionnaire included the four 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?] [Ewing, 1984]. ''Yes'' responses to at least three of these four questions was considered a high CAGE score [Zwerling et al., 1996b]. In addition, information was collected on current alcohol use and current amount of alcohol consumed. The cigarette-smoking questions were from the Third National Health and Nutrition Examination Survey [National Center for Health Statistics, 1994]. Current smokers were defined by cigarette smoking at the time of the study; ex-smokers had smoked at least 100 cigarettes lifetime, but reported they had stopped smoking at the time of the study.

The following questions were used to assess attitude towards risk [Harrell, 1995] (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.'' For questions 2, 4, and 5, disagreement was counted as a zero and agreement as a 1. For questions 1 and 3, agreement was counted as a zero while disagreement was counted as a 1. A subject was classified as ''risk averse'' if their cumulative score was 0–2 and ''risk accepting'' if their score was 3–5 [Alavanja et al., 2001].

The safety training questions were on source, date, and duration of training in any organized farm safety program or course. These questions covered any safety program, not just injury or fall-prevention training. The farm finances and products questions, covering the 12 months immediately prior to the interview, included: number of acres farmed; current farm debt as a percent 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.

Data Analysis

A non-parametric test (Wilcoxon rank sum) was used to compare ages and years of exposures between cases and controls. Logistic regression analysis adjusted for age was used to assess the relationship between each risk factor and the outcome variable, fall-related farm injury. The method of Higgins and Koch [1977] was used to select variables to be included in the multivariable model. In this method, the Mantel and Haenszel chi-square test [1959] was used initially to assess the relationship between each independent variable and the outcome variable. To adjust for age, the age variable was included for age stratification carried out at the first step, followed by re-analysis of the remaining variables. The variable with the largest chi-square/degrees of freedom that was significant at $P \leq 0.05$ was then chosen for stratification, followed by re-analysis of the remaining variables. That procedure was continued until no further variables entered the model. The selected independent variables formed the final (base) model (shown in Table III). The selected variables were then entered into a multivariable logistic regression model using forward selection. When results of that model were compared with a backward elimination model, there were no differences in the variables remaining in the base model. The goodness of fit of the resulting model [Hosmer and Lemeshow, 1989] was assessed. The variables depression, stress, and attitudes towards risk were then added, one-by-one to the base model, to assess their associations with fall-related injury, while adjusting for the variables in the base model. Since these three variables (depression, stress, and attitudes towards risk) could have preceded the injury or could have resulted from the injury, they were only tested in the model after all other predictors had been included or excluded.

The unit of analysis was the individual farmer, regardless of how many injuries the farmer reported. Each subject who participated in the computer-assisted telephone interview received $10. The study was reviewed and approved by the University of Iowa Institutional Review Board on Human Subjects.

RESULTS

The 79 farmers reported 85 falls in the previous year. Seventy-four farmers reported one fall, four reported two falls, and one reported three falls. Nineteen of the 79 farmers

(24%) required hospitalization for their fall injury. Mean ages did not differ between cases and controls (50.3 ± 15.8 vs. 49.9 ± 12.5; $P = 0.88$). Cases and controls reported similar numbers of years of farming experience (30.0 ± 13.2 vs. 29.1 ± 11.9; $P = 0.54$). All cases and controls were white. Table I shows the nature of injury, major part of body affected, source of injury, and type of fall-related event for the 85 fall-related injuries.

Forty-five of the 85 falls (53%) occurred during the 3-month period from September through November. Events accounting for those 45 included 10 falls from ladders, 10 falls from combine steps or parts, 6 falls from tractor steps, 4 falls on ice, and 15 other various fall events.

Table II shows the results of bivariate associations with fall-related farm injury. Farmers who reported the following had significantly elevated odds of fall-related farm injury: ex-smokers, wearing a hearing aid, difficulty hearing normal conversation (even with a hearing aid, in the case of those who used one), doctor-diagnosed arthritis or rheumatism, doctor-diagnosed depression, high depression score, pre-existing disability, and taking medications regularly. Having large livestock on the farm was nearly significantly associated with fall-related farm injury in the bivariate analysis.

TABLE I. Characteristics of the 85 Fall-Related Injuries Among 79 Farmers With Fall-Related Injury in the Past 12 Months in Iowa, 1997

	No. of injuries	%Total injuries
Nature of injury		
Sprains, strains, tears	28	32.9
Fractures	24	28.2
Dislocations	13	15.3
Bruises, contusions	9	10.6
Other[a] or unspecified	11	12.9
Part of body injured		
Shoulder	20	23.5
Lumbar region or back	22	25.9
Hip or leg	8	9.4
Wrist, arm, or elbow	7	8.2
Knee or ankle	13	15.3
Other[a] or unspecified	15	17.6
Source of injury		
Combine	11	12.9
Tractor	9	10.6
Other machinery or vehicle	13	15.3
Cattle	9	10.6
Other large livestock	10	11.8
Ladder	8	9.4
Other[a] or unspecified	25	29.4
Fall event causing injury		
From nonmoving vehicle	28	32.9
To floor, walkway, or other surface	21	24.7
From ladder	10	11.8
To lower level	6	7.1
Other or unspecified	20	23.5

[a]All remaining categories, each of which accounted for fewer than 6% of injuries, were included within "other."

Results from the multivariable regression model are shown in Table III. The following three variables continued to be significantly associated with fall-related injuries after adjusting for age: difficulty hearing normal conversation; doctor-diagnosed arthritis/rheumatism; and taking medications regularly. Middle age (40–64 years) was also associated with fall-related injury and there was a trend for an association with older age (greater than 65 years) also. Three variables significantly related to fall-related farm injury in bivariate analyses did not remain significant in the multivariable model (ex-smoker, wearing a hearing aid, pre-existing disability). Two variables significant in bivariate analyses were not allowed to enter the multivariable model because they might have resulted from the fall-related farm injury (doctor-diagnosed depression and high depression score). Although it did not remain in the final model because the P value was greater than 0.05 at 0.0524, having large livestock on the farm nearly doubled the risk of fall-related farm injury in an association that was close to significant (OR = 1.95; 95% CI = 0.99–3.83). A goodness of fit test for the final model shown in Table III resulted in a $P = 0.66$, indicating an adequate fit for this model. The R^2 statistic for the model was 0.069.

Those variables that could have resulted from injury (depression, stress, and risk attitude) were then added individually to the final model shown in Table III. None was significantly related to fall injuries.

DISCUSSION

This case-control study found that fall-related farm injuries were significantly associated with middle age (40–64 years), doctor-diagnosed arthritis/rheumatism, difficulty hearing normal conversation (even while wearing a hearing aid, in the case of those who used one), and taking medications regularly.

The seasonal distribution of fall-related farm injuries in the present study is of interest. Over half of the fall-related farm injuries occurred in the 3-months from September through November, a time period that includes the harvest season. Results of the present study are consistent with those of other studies that reported month or season of injury. Brison and Pickett [1992] reported that 8 of the 11 falls in their study occurred in the time period spanning October through March. Pratt et al. [1992] found the highest proportion of farm work-related injuries among dairy farmers occurred in the summer and fall months (June through November). Zhou and Roseman [1994] reported the highest peak injury rate in September. The temporal distribution of increased falls in autumn may be due to a combination of

TABLE II. Bivariate Associations of Risk Factors With Fall-Related Farm Injury in the Past 12 Months in Iowa, 1997

Variable[a]	No. (%) of cases with the variable	No. (%) of controls with the variable	Odds ratio (95% CI)[b]	*P* value
Demographic features				
Male gender	76 (96)	465 (98)	0.42 (0.11–1.62)	0.21
Education more than high school	41 (52)	206 (44)	1.39 (0.86–2.24)	0.18
Not married	11 (14)	47 (10)	1.41 (0.69–2.88)	0.36
Principal operator	72 (91)	414 (86)	1.70 (0.72–4.02)	0.21
Lives on farm	72 (91)	428 (90)	1.07 (0.46–2.47)	0.87
Had safety training prior to any injury	29 (37)	174 (37)	0.97 (0.59–1.59)	0.89
Farmwork experience ≤25 years	34 (43)	206 (44)	0.70 (0.37–1.32)	0.25
Personal habits				
Current smoker	7 (9)	48 (10)	0.85 (0.37–1.95)	0.71
Ex-smoker	**29 (37)**	**126 (27)**	**1.70 (1.02–2.82)**	**0.04**
Drinks alcohol currently	56 (71)	357 (75)	0.74 (0.43–1.28)	0.28
Has two or more drinks per day	17 (30)	86 (24)	1.30 (0.69–2.44)	0.43
CAGE score high	4 (6)	10 (2)	2.30 (0.71–7.40)	0.17
Farming factors				
Farm size small (≤500 acres)	38 (48)	229 (50)	0.97 (0.60–1.58)	0.89
Large livestock on farm	67 (85)	342 (74)	1.92 (1.00–3.68)	0.053
Debt/asset ratio ≥10%	47 (60)	268 (59)	0.99 (0.60–1.63)	0.95
Self-reported financial condition, poor/fair	15 (19)	95 (20)	0.93 (0.51–1.71)	0.80
Workload factors				
Farmer worked 50 or more weeks on farm in past year	61 (77)	355 (75)	1.08 (0.62–1.91)	0.76
Farmer worked 50 or more hr/week on farm in past year	49 (62)	252 (54)	1.36 (0.83–2.22)	0.22
Spouse helped 8 or more weeks on farm in past year	35 (44)	233 (49)	0.81 (0.50–1.31)	0.39
Spouse helped 2 or more hr/week on farm in past year	40 (51)	230 (49)	1.06 (0.66–1.71)	0.81
Others helped 12 or more weeks on farm in past year	45 (57)	213 (45)	1.59 (0.99–2.57)	0.6
Others helped 24 or more hr/week on farm in past year	43 (56)	234 (50)	1.25 (0.77–2.04)	0.36
Farmer worked part-time on farm past year	6 (8)	52 (11)	0.67 (0.28–1.61)	0.36
Farmer had job off farm past year	24 (31)	157 (33)	0.88 (0.53–1.48)	0.60
Farmer worked 12 or more weeks off farm in past year	15 (19)	115 (24)	0.74 (0.41–1.35)	0.31
Medical conditions				
Wears eyeglasses	51 (65)	317 (67)	1.00 (0.58–1.72)	0.97
Self-reported vision poor/fair	2 (3)	31 (7)	0.39 (0.10–1.56)	0.18
Wears hearing aid	**5 (6)**	**11 (2)**	**3.16 (1.11–9.00)**	**0.03**
Self-reported hearing poor/fair	19 (24)	95 (20)	1.29 (0.74–2.26)	0.37
Difficulty hearing normal conversation (even with hearing aid in the case of those who used one)	**28 (35)**	**106 (23)**	**1.93 (1.16–3.19)**	**0.001**
Doctor-diagnosed arthritis/rheumatism	**23 (30)**	**74 (16)**	**2.60 (1.49–4.52)**	**0.0007**
Doctor-diagnosed depression	**8 (10)**	**23 (5)**	**2.37 (1.04–5.41)**	**0.03**
Depression score high	**15 (19)**	**38 (8)**	**2.71 (1.43–5.13)**	**0.002**
Doctor-diagnosed heart disease	12 (15)	49 (10)	1.76 (0.88–3.53)	0.11
Doctor-diagnosed asthma	7 (9)	20 (4)	2.27 (0.95–5.45)	0.06
Pre-existing disability	**21 (29)**	**82 (17)**	**1.98 (1.14–3.45)**	**0.02**
Sleepiness score high	38 (48)	216 (46)	1.12 (0.70–1.81)	0.62
Takes medication regularly	**37 (47)**	**157 (33)**	**2.09 (1.26–3.46)**	**0.004**
Risk acceptance and stress				
Risk acceptance score high	11 (17)	72 (19)	0.85 (0.42–1.70)	0.65
Stress score high	19 (24)	78 (16)	1.56 (0.90–2.73)	0.12

[a]For variables in bold, their age-adjusted confidence interval does not include 1.00.
[b]Age-adjusted odds ratio and 95% confidence intervals.

TABLE III. Multiple Logistic Regression Analysis of Risk Factors for Fall-Related Farm Injury in the Past 12 Months in Iowa, 1997

Independent variable	Odds ratio[a]	95% Confidence interval
Age (years)		
22–39	1.00	Reference category
40–64	2.21	(1.20–4.07)
≥65	2.29	(0.94–5.54)
Doctor-diagnosed arthritis/rheumatism	2.05	(1.11–3.79)
Difficulty hearing normal conversation (even with a hearing aid, in the case of those who used one)	1.82	(1.07–3.08)
Takes medication regularly	1.80	(1.02–3.18)

[a]Each odds ratio has been adjusted for all other independent variables in the table.

seasonal factors including performing harvesting activities under time pressure and under varying environmental conditions.

Doctor-diagnosed arthritis or rheumatism was associated with fall-related farm injury in the present study. This result is consistent with that of Hwang et al. [2001] who found that farmers with joint symptoms were 2.5 times more likely to report a farm work-related injury than farmers with no joint symptoms. Thirty-seven of their 174 farm injuries were classified as falls. They did not present an analysis of risk factors for the subgroup with fall injuries. The previous case-control study of fall-related injury on the farm [Nordstrom et al., 1996] did not assess doctor-diagnosed arthritis or rheumatism. Doctor-diagnosed arthritis or rheumatism was a significant risk factor for both fall-related farm injuries in the present study and in the previous study of animal-related injuries [Sprince et al., 2003b]. Present results are also consistent with those reported in a study of non-farmers with disabilities, which showed an increased risk of occupational injury among those reporting arthritis [Zwerling et al., 1997]. An explanation of the present study result may be that arthritis limits mobility and may affect agility and balance needed to prevent falls. Recall bias and direction of causality should be addressed. Because farmers who have had a fall-related injury may recall a doctor's previous diagnosis of arthritis or rheumatism more readily than farmers who have not experienced such an injury, this possible explanation cannot be excluded. Although some injuries may result in arthritis, we believe that the fall-related injuries reported in the present study had occurred too recently to have resulted in arthritis. Because we did not collect information on previous injuries on the farm, we cannot assess the association between previous injury and current arthritis/rheumatism or previous injury and the risk of present fall-related injury.

In a series of studies assessing sensory impairments and other potential risk factors for occupational injury, hearing was found to be a significant risk factor [Zwerling et al., 1996a, 1997, 1998a,b]. Several studies have assessed hearing impairment as a risk factor specifically for farm work-related injury [Zwerling et al., 1995; Browning et al., 1998; Crawford et al., 1998; Lewis et al., 1998; Hwang et al., 2001; Park et al., 2001]. Hwang et al. [2001] was the only one of those studies to report a significant association between hearing impairment and work-related farm injury. In case-control studies, wearing a hearing aid was a risk factor for farm work-related overall injury [Sprince et al., 2003a], animal-related injury [Sprince et al., 2003b], and machinery-related injury [Sprince et al., 2002]. Although these results suggest that difficulty hearing may be a general risk factor for many types of injury, a direct causal pathway between hearing impairment and fall-related farm injury is not apparent. Future phases of the AHS or other prospective studies could address this hearing/injury association more fully.

The previous study of risk factors for overall farm injury [Sprince et al., 2003a], from which the current subgroup with fall-related farm injuries was drawn, also showed an association between medications and farm work-related injury in the past year. In that study and in the present study, the size of medication subclasses was too small to allow us to assess the relationship between specific medication subclasses and injury. A previous study reported findings suggesting an association between prescription medication use and farm work-related injury [Brison and Pickett, 1992]. Other studies have reported that specific classes of medications increase the risk of occupational injury [Gilmore et al., 1996; Pickett et al., 1996]. Several possibilities could explain the finding of an association between medications and falls. It is possible that side effects of medications may affect alertness and ability to maintain an upright posture to prevent falling. Another possibility is that the true association is between the underlying condition being treated by the medication and fall-related injury. Future phases of the AHS or other prospective studies could be designed to assess these possible explanations.

There are several study limitations that should be considered when interpreting the results. Differential recall and reporting of risk factors based on injury status is a possible limitation. Generalizing these results to all Iowa farmers should be done with caution because these study participants were younger, worked on larger farms, and applied pesticides more frequently than Iowa farmers [Sprince et al., 2002]. In contrast to a case-control study of ladder falls [Cohen and Lin, 1991], the current study was designed to assess more general and longstanding risk factors. Cohen and Lin [1991] suggested that factors closer to the fall event (such as work on slippery surfaces and use of inappropriate or unsafe ladders) with odds ratios of 4 to 5

were stronger predictors of falls from ladders than more general or distant factors (such as risk-taking tendency as measured by driver's license suspension or changes in sleep patterns) with odds ratios of 2 to 3. The present study was limited by aims and methods that did not include an assessment of immediate circumstances or environmental factors preceding the fall-related farm injury or reconstruction of the events leading to the fall injury.

One of the major strengths is the size of the overall farm injury study, which allowed us to assess risk factors for major subgroups of farm work-related injury, specifically fall-related farm injury. Nesting this study in the Agricultural Health Study provides the potential to further assess important injury risk factors prospectively in this large, well-characterized cohort. The high response rate helps ensure that the results are reflective of risk factors among all Agricultural Health Study participants.

In summary, this study identified risk factors for an important subgroup of farm work-related injuries, falls on the farm. The risk factors identified were those related to increasing age and health impairments, including arthritis, hearing impairment, and taking medications regularly. Although age and health impairments are not directly modifiable risk factors, their identification may have important implications for prevention. Further research efforts should be directed at identifying accommodations and strategies needed to prevent injury in aging farmers with health impairments.

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