The Relationship Between Fatigue-Related Factors and Work-Related Injuries in the Saskatchewan Farm Injury Cohort Study

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Background *The objective was to examine the relationship between seasonal variations in sleep quantity and work-related injuries on Saskatchewan farms.*
Methods *A cross-sectional analysis of data from the Saskatchewan Farm Injury Cohort Study was conducted. Analyses were restricted to workers, aged ≥16 years. The primary outcome was work-related injury in the last year. Logistic regression models were used to identify associations between sleep quantity and farm injury.*
Results *After controlling for confounding variables peak production season sleep was not associated with increased odds of injury. However, those obtaining ≤5 hr sleep per night during non-peak production seasons had increased odds of injury (OR 2.42, 95% CI 1.04–5.59) compared with those sleeping ≥7 hr per night.*
Conclusions *We identified that restricted sleep durations, in certain seasons, placed farmers, and farm workers at risk of injury. Agricultural injury intervention programs need to consider the role of seasonal-related variations in sleep on farm injury.* Am. J. Ind. Med. 55:367–375, 2012. *© 2011 Wiley Periodicals, Inc.*

KEY WORDS: agriculture; safety; work-related injury; sleep; fatigue

INTRODUCTION

The potential impact of fatigue or on-the-job sleepiness on workplace safety is well-recognized [White and Beswick, 2003; Caruso et al., 2006; Philip and Akerstedt, 2006; Knauth, 2007; Williamson et al., 2011]. Fatigue has been associated directly with an increased risk of injury and near-miss incidents in workers [Lilley et al., 2002; White and Beswick, 2003; Philip, 2005]. Long working hours, and the resulting restricted sleep opportunities, are both risk factors associated with an increased risk of injury at work through the intermediary condition of fatigue [White and Beswick, 2003; Philip, 2005; Knauth, 2007]. Fatigue influences injury risk by impairing such functions

Abbreviation used: SFIC, Saskatchewan Farm Injury Cohort study.

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Contract grant sponsor: Canadian Institutes of Health Research; Contract grant number: 200503MOP-145294-PUB-CCAA-56847 Canadian Centre for Health and Safety in Agriculture CDA-66151.
Disclosure Statement: The authors report no conflicts of interests.

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Accepted 8 December 2011
DOI 10.1002/ajim.22003. Published online 27 December 2011 in Wiley Online Library (wileyonlinelibrary.com).

as attention maintenance, multi-tasking, decision making, situational awareness, and risk taking [Caldwell et al., 2008]. The impact of fatigue may be greatest for jobs or occupations requiring sustained attention to task and involving complex work with a slim margin for error [White and Beswick, 2003; Williamson et al., 2011]. To illustrate, the role of fatigue as an important risk factor for work-related injuries is well-established in some industry groups such as transportation [Philip and Akerstedt, 2006; Williamson et al., 2011].

Agriculture is one of the most hazardous industries globally, with injury to farmers and farm workers exacting high rates of injury mortality and morbidity [Forastieri, 1999; McCurdy and Carroll, 2000]. The length of working hours and subsequent time available for sleep in farming is frequently determined by agricultural production demands that vary by season. Seasonal tasks may need to be undertaken quickly to take advantage of favorable weather conditions. Agricultural workers may dedicate themselves to a work task for extremely long periods of time [Pickett et al., 1995], sometimes without sleep or rest breaks. Therefore farming provides many challenges and requires balance between seasonally fluctuating working hours, restricted sleep opportunities and varying production demands. Agricultural work is highly mechanized and can be unpredictable in nature. Many tasks undertaken on a farm are skilled operations requiring a high degree of alertness and attention [Rasmussen et al., 2000]. In addition, there is a slim margin of error and a large reservoir of high energy potential associated with many agricultural work tasks [McCurdy and Carroll, 2000]. Therefore, fatigue arising from long hours of work and subsequent sleep deprivation, may constitute a significant risk factor for injury in agricultural workers.

However, while increases in yearly or weekly hours of work have indeed been consistently associated with elevated risks for farm injury [McCurdy and Carroll, 2000; Hwang et al., 2001; Sprince et al., 2003; McCurdy et al., 2004; Day et al., 2009], the evidence for sleep quantity and quality as a risk factor for farm injury has been contradictory. While one study in a heterogeneous rural population, including farmers, found significantly increased risks for injury with <7 hr sleep per night [Choi et al., 2006], another in adolescent farm residents found sleep of <8.5–9.25 hr increased risk of farm injury [Stallones et al., 2006]. Other studies in older farming populations find increased risks only for poor sleep quality, particularly for those suffering from sleep apnea [Spengler et al., 2004; Heaton et al., 2010]. One Australian study has found excessive daytime sleepiness associated with lower odds of serious work-related injury [Day et al., 2009].

Previous studies of sleep quantity and quality have mostly examined populations with limited generalizability to the broader farming community and there has been little examination of the impact of seasonal variations in sleep quantity despite seasonal patterning in the occurrence of agricultural injuries [Rasmussen et al., 2000]. This article examines the relationship between seasonal variations in sleep quantity, sleep quality, and work-related injuries in farmers and farm workers in the Saskatchewan Farm Injury Cohort (SFIC), a large population-based Canadian farming cohort. Our hypotheses were: (i) that the most sleep-deprived farmers experience an elevated risk for injury, and (ii) these risks were likely to be highest during seasons with the highest level of farm productivity (spring, summer, and fall).

MATERIALS AND METHODS

Saskatchewan Farm Injury Cohort Study Overview

The SFIC study base consists of active, operating farms in the Province of Saskatchewan as of January 1, 2007, farms were identified from two sources: (i) a list of farms in rural municipalities that participated in the Saskatchewan Agricultural Health and Safety Network (AHSN); and (ii) a list of farms in non-AHSN rural municipalities. The sample was stratified with clusters of farms nested within rural municipalities evenly split between AHSN and non-AHSN municipalities. Farms were recruited by mail. Response rates were 94% (50/53) at the rural municipality level and 33% (2,390/7,246) at the farm level [Pickett et al., 2008]. Further details on the methodology including sampling are described elsewhere [Pickett et al., 2008].

Baseline data were collected in a survey of residents from 2,390 Saskatchewan farm operations between January and April 2007 by means of a mail questionnaire using the principles described by Dillman [2000]. The study questionnaire was completed by an adult key informant on each participating farm and included information on the farm operation, farm dwellers, and workers, farm safety hazards, farm safety practices and the occurrence of injury related to farm work and the farm work environment. Informed consent was implied by return of a completed questionnaire. The study was approved by the Research Ethics Board of the University of Saskatchewan.

Saskatchewan Farm Injury Cohort Sleep Study

We undertook a cross-sectional study nested within the baseline sample of the prospective SFIC. A causative mechanism model was developed based on literature and expert knowledge (Fig. 1). The analysis was guided by this model and utilized selected farm and farm worker variables, and the primary outcome of farm injury for

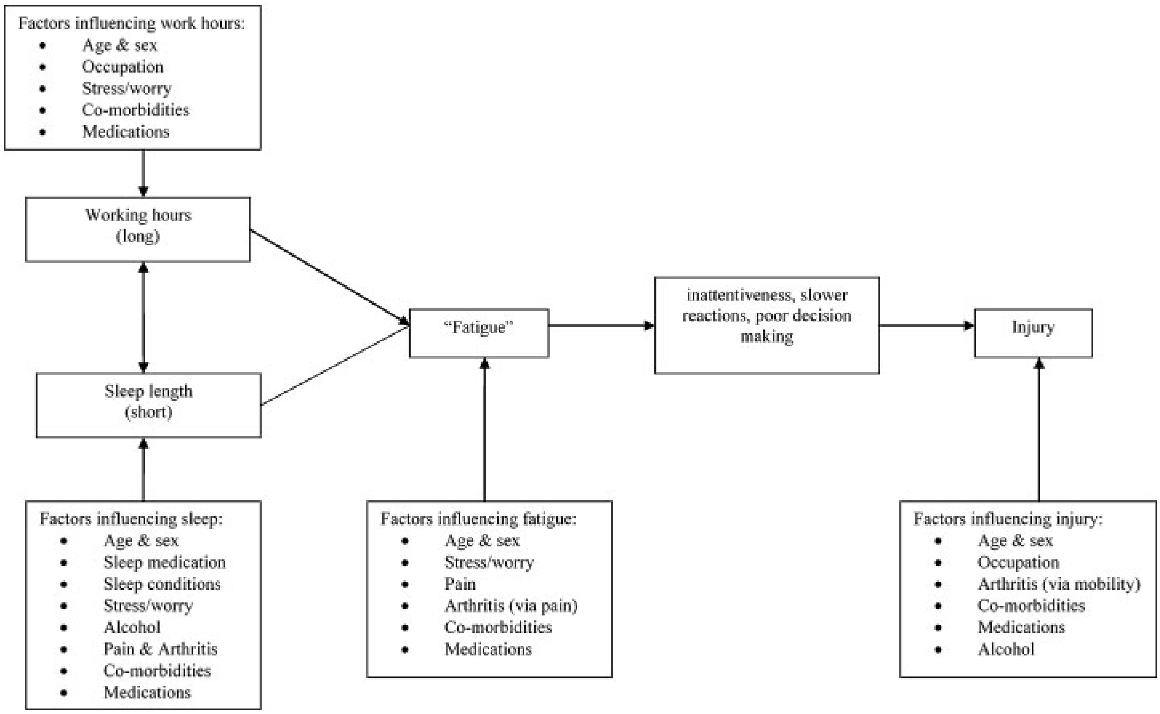

FIGURE 1. Proposed mechanism model for the relationship between fatigue-related factors and injury in the SFIC.

workers aged 16 years and over at the time of survey. The analysis primarily focused on the relationship between sleep quantity (stratified according to season), sleep quality, and work-related injury.

Definition of Study Variables

The primary exposure variables were collected from each individual. Non-peak season sleep was defined as the number of reported hours of sleep a person normally gets at night, while peak season sleep was the number hours of sleep a person gets during ‘‘busy’’ farm seasons. In Saskatchewan, the peak production seasons span from mid April though to late October, crossing spring, summer, and fall. Non-peak and peak season sleep were collected using modified questions from Choi et al. [2006] with categorical responses: >7; 6–7; and ≤ 5 hr sleep per night. Additional sleep quality exposure variables of loud snoring, sleep apnea, and sleep medication use were dichotomous variables categorized ‘‘yes’’ and ‘‘no.’’

Potential confounders collected by the SFIC were assessed as follows. Average weekly working hours of farm work were collected by season of work and were grouped into categories (<30, 30–59, 60–79, and ≥ 80 hr/week) for analytical purposes. Main occupation was reported as either a ‘‘farm’’ or ‘‘off-farm’’ occupation. Where multiple occupations are held, those averaging >30 hr/week of farm work were considered to have farming as a main occupation. Alcohol consumption was measured by the question ‘‘during the past 12 months, how often did this person drink alcoholic beverages,’’ and for regression analyses responses were grouped into three categories: never, less than daily, and daily. Age was collected as a continuous variable and kept as such for regression analyses. Worry due to cash flow was a farm level variable measured as one item ‘‘how often were cash flow shortages a source of worry on your farm’’ with five response categories: everyday, at least once a week, at least once a month, less than once a month, never. For regression analyses, the variable was regrouped into two categories: daily and less than daily. Both co-morbid arthritis and pain medication use were collected as dichotomous (yes, no) categorical variables.

The outcome variable was the self-reported occurrence of farm injuries during the calendar year of 2006. Farm injuries were defined as all injuries that occurred in a farm environment including injuries occurring off farm but involving farm work (e.g., driving tractor on public road). Our analyses restricted the injury outcome variable to work-related injuries only: recreational injuries were excluded. Where there was more than one injury event for the 2006 calendar year participants were asked to report on the most serious injury that had occurred. Injury incidents were grouped by season according to month of occurrence for analysis. Injuries occurring April to October were grouped into peak agricultural production months while injuries occurring November to March were grouped into non-peak production months. Work-relatedness was established using a single item asking if the injured person was working at the time of injury, which was cross checked for accuracy using the free text narrative of the injury event.

Statistical Analysis

Data from the SFIC baseline interviews were collected, coded, and entered into an Access database. Analyses were undertaken using Stata version 8.0 SE. Analyses were restricted to workers (main occupation farm or off-farm) who were at least 16 years of age at the time of survey.

Categorical variables were summarized using percentages. Bivariate associations with work injury were tested using Chi-square analyses. Missing values have been considered to be missing at random. Logistic regression modelling was directed by the causative model (Fig. 1). Independent exposure variables were regressed against the occurrence or not of any work-related injury in 2006, restricted to the relevant season (peak, non-peak production months) under examination, using multiple logistic regression with simultaneous adjustment for potential confounders. The a priori confounders of age, gender, and main occupation were included in all models. A relationship between increased hours of work and reduced sleep opportunity was expected therefore hours of work was added to all sleep quantity models as a potential confounder. Inclusion of other potential confounding variables was indicated by examining their effect on the estimates for other key exposures using logistic regression modelling. Variables altering the β co-efficient associated with the primary exposure variable by at least 10% were included [Maldonado and Greenland, 1989]. Alcohol consumption has been included as a control variable in the analysis, because alcohol is a known effect modifier in the relationship between sleep quantity and injury [Choi et al., 2006], and we are interested in the extent to which sleep duration has an effect on farm injury other than by altering alcohol consumption. The unit of analysis was the individual. All models were adjusted for the clustered farm sample design. Odds ratios and associated 95% confidence intervals were estimated for the key exposures. For the categorized continuous variables of peak and non-peak work hours and sleep linear stepwise linear trends were tested by entering the categories as a continuous variable using logistic regression.

RESULTS

Detail on the SFIC baseline recruitment rates are published elsewhere [Pickett et al., 2008]. A total of 4,439 participants from 2,269 farms in the SFIC were classified as workers (both part-time and full-time farm operators and farm workers) aged 16 years and above. Demographic characteristics of this working population are shown in Table I. The majority of workers were males (62%), and were aged 40–59 years of age (58%). The predominant farming arrangement was an individual family farm (62%). Major commodities produced were grain (88%) and beef (53%) and most farms who reported a farm size (76%) were between 501 and 2,500 acres in size.

A larger proportion of farmers and farm workers were reporting <5 hr sleep during peak production season, compared with the non-peak season, for all demographic and work-related factors examined (Table II). Close to a quarter of those aged <60 years reported < 5 hr sleep per night during peak production season. Males, those whose main occupation was farming, those reporting daily economic worry, working >60 hr/week and those consuming alcohol on a daily basis were more likely to report ≤5 hr sleep per night in the peak production season.

A total of 344 work-related injuries were reported by farmers and farm workers in the previous 12 months (344/4,439 7.7%). Of these work-related injuries, 217 (63%) received medical treatment, with 144 (33%) treated at a hospital or emergency room. The prevalence of work-related injury was relatively constant across the age groups, although highest in the 40–59 age group (Table III). Males and those who had a main occupation of farming were most likely to report a work-related injury in the previous 12 months. In terms of work-related factors, those reporting daily economic worries, and long working hours (<60 hr/week), in either peak or non-peak production periods, were most likely to report a work-related injury. The exception was workers reporting working ≥80 hr/week on the farm in the non-peak agricultural production season where the rate of injury was lower than the rate observed for those working 60–79 hr (2.6% vs. 4.8%) in the same season. Farmers and farm workers reporting daily alcohol consumption had a significantly higher prevalence of work-related injury (22%), compared with never drinkers (5%) and those who drink alcohol less frequently (8%).

The prevalence of work-related injury was lowest for those reporting ≥7 hr per night regardless of production season (Table IV). Work-related injury increased in prevalence as the amount of sleep decreased regardless of production season. Prevalence of injury during the peak season was over twice that of the non-peak season for all levels of nightly sleep duration. For example, 8.9% of those getting ≤5 hr sleep during the peak production season sustained a work-related injury in the previous 12 months, compared with 3.4% in non-peak production seasons. An ordinal trend was also observed with decreasing quantities of both peak and non-peak sleep. The

TABLE I. Demographic Characteristics of Study Subjects From the Saskatchewan Farm Injury Cohort (n = 4,439)

Characteristics	n	%
Sex		
Male	2,745	62
Female	1,685	38
Age (years)		
16–39	839	19
40–59	2,542	58
60–79	938	21
80+	56	1
Education		
Less than High School	889	20
Completed High School	1,794	40
Completed University	735	17
Institution other than above	1,003	23
Operating arrangement (n = 2,269)		
Individual family farm	1,451	66
Partnership	430	20
Family corporation	290	13
Other	29	1
Leading commodity types[a] (n = 2,269)		
Grain	3,899	88
Beef	2,417	53
Pigs	45	2
Vegetable/fruit	41	2
Dairy	11	1
Other animal	200	9
Total acres (n = 2,269)		
0–500	455	20
501–1,500	815	35
1,501–2,500	445	20
>2,500	450	20
Missing	104	5

[a]Multiple options allowed.

prevalence of work-related injury was significantly higher in those who reported suffering from loud snoring (11%), compared with non-snorers (7%). There were no statistically significant differences in prevalence of work-related injury for sleep medication use or sleep apnea.

Peak season sleep of 6–7 and ≤5 hr per night, and non-peak season sleep of ≤5 hr sleep per night were crudely associated with increased odds of work-related injury in their respective seasons (Table V). After adjusting for confounding variables, including seasonal working hours, the odds diminished for peak season sleep. An association between non-peak season sleep and work-related injury remained after controlling for confounding, with those obtaining ≤5 hr sleep per night in non-peak seasons having 2.4 times the odds of injury (OR 2.42, 95% CI: 1.04–5.59), compared with those sleeping ≥7 hr sleep per night. A linear trend in the adjusted odds of injury was also observed with decreasing sleep in non-peak seasons. Loud snoring was crudely associated with an increased risk of work-related injury. However, this association disappeared with the addition of confounding variables. Sleep apnea and sleep medication use was not examined due to limited statistical power.

DISCUSSION

This study found the majority of farmers and farm workers in this Saskatchewan farming population obtain 7 hr, or less, sleep per night on average, regardless of season. Short sleep durations are prevalent with a quarter of farmers and farm workers aged <60 years old sleeping ≤5 hr per night during peak production seasons. Seasonal variations were noted, with short sleep durations more common in peak production seasons than non-peak seasons. We expected to see an increase in risk of injury with decreasing sleep quantity regardless of season, however, once confounding variables were added only non-peak seasonal sleep of ≤5 hr per night remained statistically significant. These results provide partial support for our first hypothesis, that the most sleep-deprived farmers experienced an elevated risk for injury. There is also partial support for our second hypothesis that the risk of injury is likely to be highest during seasons with the highest level of productivity, namely spring, summer and fall. Sleep quality, as measured in our study, was not associated with an increased risk of work-related injury.

Our findings indicate Saskatechewan farmers and farm workers are often chronically sleep deprived during peak production periods. Prevalence of short sleep durations during peak season in Saskatechwan farmers and farm workers is in the same order of magnitude as in US Agricultural, Forestry, Fishing and Hunting industries where 23% reported short sleep durations of <6 hr per night. [Luckhaupt et al., 2010] Other occupational groups with higher prevalence rates of short sleep include those managing companies and enterprises (40%), and those in the transport and warehousing (37%) and manufacturing (35%) industries [Luckhaupt et al., 2010].

The relationship between quantity of sleep and farm-related injury from previous studies in farmers is conflicting. Two studies, one in farm adolescents [Stallones et al., 2006] and one in a rural population, including farmers [Choi et al., 2006], found an association between insufficient sleep and injury, while a study in an older, part-time farming population found no association between sleep quantity and risk of injury [Spengler et al., 2004]. All previous studies have made the assumption that sleep was constant over the farm year. In contrast, our study indicates that sleep patterns vary with agricultural season.

TABLE II. Distribution of Sleep Quantity in Last 12 Months by Demographic and Work-Related Factors

Variable	Non-peak season sleep				Peak season sleep			
	≤5 hr, n (%)	6–7 hr, n (%)	≥7 hr, n (%)	*P*-value	≤5 hr, n (%)	6–7 hr, n (%)	≥7 hr, n (%)	*P*-value
Age								
≤39 yr	34 (7)	404 (86)	34 (7)	0.7	201 (24)	429 (52)	203 (24)	<0.0001
40–59 yr	133 (8)	1,306 (84)	133 (8)		587 (23)	1,429 (58)	473 (19)	
≥60 yr	43 (7)	513 (86)	43 (7)		136 (14)	561 (57)	287 (29)	
Gender								
Female	66 (4)	725 (43)	886 (53)	<0.0001	197 (12)	935 (56)	544 (32)	<0.0001
Male	145 (5)	1,426 (52)	1,155 (42)		737 (27)	1,543 (57)	432 (16)	
Main occupation								
Off farm	62 (4)	761 (51)	682 (45)	<0.0001	230 (15)	844 (56)	426 (29)	<0.0001
Farming	150 (5)	1,392 (48)	1,363 (47)		705 (36)	705 (36)	553 (28)	
Daily farm cash-flow stress[1]								
Not everyday	98 (4)	1,289 (47)	1,368 (49)	<0.0001	460 (17)	1,609 (58)	680 (25)	<0.0001
Everyday	101 (7)	768 (53)	570 (40)		426 (30)	764 (53)	241 (17)	
Work hours—avg. peak season (sum/spr/fall)[1]								
≤29 hr/week	69 (4)	731 (46)	793 (50)	<0.0001	207 (13)	878 (55)	509 (32)	<0.0001
30–59	42 (4)	471 (49)	459 (47)		175 (18)	582 (60)	210 (22)	
60–79	33 (5)	347 (50)	309 (45)		178 (26)	410 (60)	99 (14)	
≥80	52 (8)	365 (54)	253 (38)		284 (43)	323 (49)	58 (8)	
Alcohol consumption								
Never	43 (6)	322 (43)	381 (51)	0.005	147 (20)	388 (52)	208 (28)	<0.0001
Less than daily	164 (5)	1,790 (50)	1,661 (45)		762 (21)	2,046 (58)	745 (21)	
Daily	4 (5)	30 (40)	41 (55)		21 (28)	35 (46)	20 (26)	

[1]Restricted to peak agricultural production months (spring-fall).

Sleep of ≤5 hr per night in non-peak production seasons was found in our study to be associated with an increased risk of work-related farm injury. This pattern of injury risk was unexpected and contrary to the hypothesis. Compared with other seasons, winter tasks on Saskatchewan farms are less varied, mainly involving machinery maintenance, grain handling, and enclosed animal rearing. Machinery repair and maintenance are reported to be the most hazardous tasks per hours worked [Rasmussen et al., 2000]. Other factors that could be associated with an increased risk of injury in winter include working in severe sub-zero temperatures, prolonged and monotonous winter work [Williamson et al., 2011], reduced daylight [Plainis et al., 2006], or the absence of co-workers [Lindsay et al., 2004].

Like sleep quantity, the relationship between sleep quality and work-related injury in the farming population is unclear, although on balance, the evidence supports an association between daytime sleepiness or sleep apnea symptoms and injury risk [Spengler et al., 2004; Choi et al., 2006; Stallones et al., 2006; Day et al., 2009; Heaton et al., 2010]. The lack of association in our study may be a reflection of our more age representative farming cohort, since sleep quality deteriorates with age [Carskadon and Dement, 2005], and two of these previous studies included a higher proportion of older farmers [Spengler et al., 2004; Heaton et al., 2010]. Further, our study had limited power to examine sleep quantity due to low prevalence of poor sleep factors.

This study is limited by the cross-sectional design which is unable to demonstrate temporal relationships. Errors in recall may have occurred since data collection took place in January to April for injuries in the previous calendar year, creating the possibility of enhanced recall of injuries occurring later in the year. However, a seasonal analysis has been employed and since the winter season captures both the start and end of the calendar year, any enhancement in recall would be balanced out by an expected deterioration in recall for the beginning of the previous calendar year. The possibility of recall bias by the farm informant reporting injuries in this baseline data alongside exposure information is also a potential limitation. As the data are self-reported the occurrence of an injury may have made the participant more likely to remember potential risk factors. The use of informants also introduces a further potential source of recall bias and misclassification. However, it is a strength of this study that seasonal fluctuations in sleep quantity, working hours

TABLE III. Distribution of Work Injury in Last 12 Months by Demographic and Work-Related Factors

Variable	Total n	Work injury n	Work injury %[a]	*P*-value
Age				
16–39	830	53	6.4	0.1
40–59	2,512	223	8.9	
60–79	926	61	6.6	
80+	55	4	7.3	
Total	4,323	341	7.9	
Gender				
Female	1,671	57	3.4	<0.0001
Male	2,707	287	10.6	
Main Occupation				
Off farm	1,501	63	4.1	<0.0001
Farming	2,885	281	9.7	
Daily farm cash-flow stress[b]				
Not everyday	2,608	109	4.0	0.011
Everyday	1,343	82	5.8	
Alcohol consumption				
Never	742	42	5.6	<0.0001
Less than daily	3,534	283	8.0	
Daily	75	17	22.7	
Work hours—avg. peak season[b]				
≤29 hr/week	1,517	63	3.9	<0.0001*
30–59	894	64	6.7	
60–79	613	61	9.1	
≥80	594	67	10.1	
Work hours—avg. non-peak season[c]				
≤29 hr/week	2,556	32	1.2	0.001*
30–59	832	22	2.6	
60–79	166	8	4.6	
≥80	710	19	2.6	

[a]Percentage within each category of variable.
[b]Restricted to injuries occurring in peak production season (spring/summer/fall).
[c]Restricted to injuries occurring in non-peak production season (winter).
*Test for difference between categories. Linear trend tests (non-peak $P = 0.001$, peak $P < 0.0001$).

TABLE IV. Distribution of Work Injuries by Sleep Quantity and Quality

Variable	Total n	Work injury n	Work injury %[a]	*P*-value
Non-peak season sleep[b]				
≥7 hr per night	1,982	29	1.4	0.07*
7–6 hr	2,059	44	2.1	
≤5 hr	44	7	3.4	
Peak season sleep[c]				
≥7 hr per night	927	39	4.0	<0.001*
7–6 hr	2,268	163	6.7	
≤5 hr	827	81	8.9	
Loud snoring				
Yes	273	30	11.0	0.05
No	4,113	314	7.6	
Sleep medication use				
Yes	91	5	5.5	0.40
No	4,295	339	7.9	
Sleep apnoea				
Yes	89	8	9.0	0.6
No	4,297	336	7.8	

[a]Percentage within each category of variable.
[b]Restricted to injuries occurring in peak agricultural production months (spring–fall).
[c]Restricted to injuries occurring in non-peak agricultural production months (winter).
*Test for difference between categories. Linear trend tests non-peak $P = 0.03$ and peak $P < 0.0001$.

and sources of worry/stress have been taken into account in the analyses. Further, the cohort represents the broader farming population allowing for greater generalizability than previous examinations of farm-related injury.

Together these contrasting results indicate the need for further research to examine the relationship between sleep quantity, sleep quality and work-related injury in populations generalizable to the broader farming population. Our findings particularly indicate that seasonal fluctuations should be considered when examining the role of fatigue due to sleep deprivation in farm-related injury. Sleep deprivation may be an indicator of other factors, such as stress or chronic illness, or the result of sleep disorders, lifestyle, or work conditions. Our findings suggest that alcohol consumption and economic stress are two such factors that require further examination. Previous studies suggest economic stress is a determinant of both physical work conditions and safety practices on the farm [LaBrash et al., 2008]. The increased risk of injury with alcohol consumption is a well-established risk factor for occupational injury [Smith and Kraus, 1988] and it has a detrimental impact upon sleep quality and, hence, injury risk [Choi et al., 2006]. Interventions addressing farm-related injury need to consider the role of sleep quantity. Any intervention to reduce daytime sleepiness should initially focus on increasing sleep quantity; however, therapeutic countermeasures to reduce daytime sleepiness are available [Driskell and Mullen, 2005; Kushida, 2006].

Our study provides new evidence that seasonal fatigue-related factors are associated with agricultural work-related injuries among the Saskatchewan farm community. Future work should consider the role of seasonal fluctuations in sleep quantity when examining the impact of the fatigue-related factors of working time on injury in agriculture. The present findings suggest agricultural injury intervention programs need to consider the role of fatigue in the etiology of farm-related injury in certain seasons.

TABLE V. Adjusted Risk of Work-Related Injury Associated With Sleep Duration Among Saskatchewan Farmers

Variable	Unadjusted	Adjusted
Peak season sleep[a]		
≥7 hr per night	Ref	Ref
7–6 hr	**1.70 (1.19–2.44)**	1.43 (0.96–2.12)[b]
≤5 hr	**2.32 (1.57–3.45)**	1.48 (0.93–2.34)[b]
Nonpeak season sleep[c]		
≥7 hr per night	Ref	Ref
7–6 hr	1.46 (0.91–2.34)	1.41 (0.86–2.32)[d]
≤5 hr	**2.42 (1.04–5.59)**	**2.40 (1.02–5.68)**[d]
Loud snoring		
No	Ref	Ref
Yes	**1.49 (1.00–2.23)**	1.20 (0.79–1.83)[e]

Bolded values indicate significance ($P < 0.05$).
[a]Restricted to injuries occurring in peak agricultural production months (spring–fall).
[b]Adjusted for gender, age, main occupation, average weekly work hours in peak production period (spring–fall), daily cash flow stress (spring–fall), alcohol consumption. Test for difference between categories. Test for linear trend unadjusted $P < 0.0001$, adjusted $P = 0.1$.
[c]Restricted to injuries occurring in non-peak agricultural production months (winter).
[d]Adjusted for gender, age, main occupation, average weekly work hours in non-peak production period (winter), daily cash flow stress (winter), alcohol consumption. Test for difference between categories. Test for linear trend unadjusted $P = 0.031$ adjusted $P = 0.04$.
[e]Adjusted for gender, age, main occupation, arthritism, and pain medication use.

ACKNOWLEDGMENTS

We would like to thank Iris Rugg, Kendra Ulmer, Leanne LaBrash, Deborah Emerton, Murray Purcell, Debra Gronning, Louise Singer, Phyllis Snodgrass as well as the farm families from Central Saskatchewan who took the time to assist us with this research. We would also like to thank Professor John Langley for reviewing an earlier draft of this paper and Gabrielle Davie for her statistical advice. This study was supported financially by a research agreement with the Canadian Institutes of Health Research (Operating Grant 200503MOP-145294-PUB-CCAA-56847) and a pilot study grant from the Canadian Centre for Health and Safety in Agriculture (also funded by the Canadian Institutes of Health Research, Operating Grant: CDA-66151). Dr. Lilley was supported by a postdoctoral fellowship from the Accident Compensation Corporation, New Zealand and the Health Research Council of New Zealand (ID 07/049). Dr. Day was supported by a senior research fellowship (ID 236880) from the National Health and Medical Research Council of Australia.

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