FEATURE ARTICLE
Research

Sleep Deprivation and Injuries in Part-Time Kentucky Farmers

Impact of Self Reported Sleep Habits and Sleep Problems on Injury Risk

by Susan E. Spengler, MD, MSPH, Steven R. Browning, PhD, MSPH, and Deborah B. Reed, PhD, RNC

Abstract

Part-time farmers who hold off-farm jobs may be at risk for injuries because of impaired performance resulting from inadequate sleep. For this study, 1,004 part-time male Kentucky farmers completed a telephone interview for the 1994 to 1995 National Institute for Occupational Safety and Health-funded Farm Family Health and Hazard Surveillance Project. Questions were included about demographics, sleep habits, and injury occurrence. Twelve percent of the farmers reported an injury requiring medical intervention in the previous year. Farmers reported sleeping an average of 7.6 hours daily. Approximately 6.7% of the sample had three symptoms of sleep apnea. Although hours of sleep were not related to injury incidence, sleep medication use (odds ratio [*OR*] = 2.11, 95% confidence interval [*CI*] = 1.01 to 4.40) and presence of three sleep apnea symptoms (*OR* = 2.48, 95% *CI* = 1.13 to 5.41) were related to injury incidence. These data support the need for further research to examine sleep habits and promote strategies that reduce the risk for injuries caused by lack of sleep.

ABOUT THE AUTHORS

Dr. Spengler is Assistant Professor of Preventive Medicine and Environmental Health, College of Public Health, Dr. Browning is Assistant Professor of Epidemiology, College of Nursing & College of Public Health, and Dr. Reed is Associate Professor, College of Nursing and the College of Medicine, Southeast Center for Agricultural Health and Injury Prevention, University of Kentucky, Lexington, KY.

Despite substantial research into the etiology of occupational injuries in farmers, few investigations have examined the potential impact of sleep habits and sleep problems on the risk of injury. Several studies have demonstrated a correlation between characteristics of the farming environment or the personal characteristics of farmers and the increased incidence of injury (Browning, 1998; McCurdy, 2000). Significant increases in injuries have been noted in farmers who work with large animals, work on larger farms, and spend greater number of hours farming (Nordstrom, 1995; Pickett, 1995; Zhou, 1994, 1995).

Individual characteristics of farmers shown to increase the agricultural injury rate include (Brison, 1992; Stallones, 1990; Zhou, 1994):

- Fulltime involvement in agriculture.
- Greater number of hours spent farming.
- Male gender.
- Greater cumulative years spent farming.

Other factors hypothesized to increase injury risk include (Browning, 1998; Elkington, 1990; Zhou, 1995):

- Alcohol use.
- Prescription medication use.
- Vision or hearing difficulties.
- Lower education level.

Only one study has evaluated the role of sleep as an injury risk factor among farmers (Elkington, 1990). In that study, no significant difference was found in terms of average number of hours of sleep reported between injured farmers and those reporting no injury in the previous year (Elkington, 1990). Sleep deprivation and the risk of injury have been evaluated more thoroughly among long haul truck drivers (Arnold, 1997; Mitler, 1997; Stoohs, 1994). Studies have shown a lack of adequate sleep results in decreased attention, responsiveness, and performance (Arnold, 1997; Mitler, 1997; National

What Does This Mean for Workplace Application?

More than half of the nation's principal farm operators also hold concurrent off farm jobs. The combination of the seasonality of farm production and the demands of an off farm job may increase the risk of injury for these workers. Occupational health nurses need to be aware of the potential for sleep deprivation and reduced sleep quality for all bivocational workers. Awareness of the relationship between sleep related factors and injury is important because intervention and prevention are possible. By minimally expanding history taking to include sleep habits, potential risk factors may be identified. The use of the Epworth Sleepiness Scale may be useful in clinical settings for assessing potential problems. Counseling on such issues as the importance of restorative sleep and strategies that may be used when sleep loss is inevitable are other areas in which occupational health nurses can provide education. The results of this study also may be of interest when working with populations such as truckers, pilots, medical residents, and other groups at risk for sleep deprivation and a high occupational injury rate.

Transportation Safety Board, 1990b). Of approximately 4,800 fatal truck accidents occurring in the United States each year, fatigue was cited as the probable cause in 57% (National Transportation Safety Board, 1990a). Disturbed sleep also has been shown to result in significant performance deficits and an increase in automobile and truck crashes in those with sleep apnea (Findley, 1992; Stoohs, 1994). Sleep apnea has been associated with a twofold to threefold higher risk of motor vehicle crash in both long haul truck drivers and nonprofessional motorists compared with drivers who do not suffer from the disorder (Findley, 1992; Stoohs, 1994).

This article presents data on male Kentucky farmers age 19 and older who farm and hold another job (part-time farmers) and the relationship between their self reported sleep habits and patterns and the incidence of nonfatal injuries in the previous year. Part-time farmers represent a majority of farmers in Kentucky, with more than 50% of principal farm operators in Kentucky holding off farm jobs (U.S. Census Bureau, 1992). Kentucky farmers have a higher risk of fatal and nonfatal injuries compared to the general population and to the aggregate of agricultural workers in the United States (National Safety Council, 1995, 2001). Farmers who hold another outside job may be at especially high risk for injuries because the demands on their time are more likely to result in inadequate sleep, with consequent impaired performance and vigilance.

The specific objectives of this study were to determine whether:

- Part-time Kentucky farmers generally get inadequate amounts of sleep.
- Inadequate or erratic sleep patterns result in a high incidence of injuries in part-time Kentucky farmers.
- The perception of being sleep deprived is a predictor for injury occurrence.
- Disturbed sleep patterns (e.g., sleep apnea) result in higher injury rates.
- Use of sleeping medications or stimulants predict a higher rate of injury.

METHOD

The data used for this project were obtained from the National Institute for Occupational Safety and Health (NIOSH)-sponsored Kentucky Farm Family Health and Hazard Surveillance Project (FFHHSP), a multimodal effort to determine agricultural risks and injuries among farm families. In the FFHHSP, a two stage cluster sample of farms from 60 counties in Kentucky was used, with a farm being defined as any place where $1,000 or more of agricultural products were produced and sold, or normally would have been sold during the census year (Browning, 1999).

The number of farms in Kentucky in 1993 was estimated to be 91,281 (U.S. Census Bureau, 1992). The sample population used in this project was obtained from one of four sampling frames used in the FFHHSP: male Kentucky farmers at least 19 years old who hold another job (part-time farmers). A detailed description of the sample selection process, size considerations, data collection methods, and data management, coding, and entry is provided elsewhere (Browning, 1998, 1999).

Sample

The Farm Hazard and Demographic Enumeration Survey (FHADES) represented the first of two phases in the FFHHSP. The sampling frame for the study was constructed using a two-stage cluster sampling design. In the first stage, a sample of 60 counties from the 120 Kentucky counties using probability proportional to size sampling was selected, where size was based on the 1987 Census of Agriculture for Kentucky. Next, a sample of approximately 125 farm households per county for each of the 60 selected counties was drawn (Browning, 1998).

Phase one telephone surveys were conducted with the selected farm households to develop a listing of the household composition. In phase two, the actual data collection was accomplished through the administration of the Farm Health Interview Surveys, which consisted of 30 minute telephone interviews conducted by the University of Kentucky Survey Research Center using a computer assisted telephone interviewing system. The telephone survey instruments had been previously tested to ensure simplicity, intelligibility, and clarity (Browning, 1999).

In the first stage of the two stage cluster sampling, the sample size (number of counties) was chosen as 60 based on informal considerations taking into account the number of farms per county and the commodity distribution of farms in the state. Selection of farms within each county was based on a sample size of 1,200 farms, which was determined to meet the sample size requirements for the study. The actual sample size obtained was 1,004, which

represented an 80% response rate (Browning, 1998, 1999). Data were collected between June 1994 and September 1995 by the University of Kentucky Survey Research Center using a computer assisted telephone interviewing system. Confidentiality was ensured for all individuals who contributed data to the study, and all study protocols were reviewed and approved by the Institutional Review Board of the University of Kentucky.

Definition of Study Variables

All injuries occurring during the 12 months preceding the telephone interview were considered. The definition of an injury was limited to those cases in which farmers saw or talked to a medical physician or assistant or felt they should have seen a physician. The 1 year cumulative incidence rate of injury among the part-time farmers was calculated with the number of injury cases (farmers) as the numerator and the total number of surveyed farmers as the denominator. The analysis was based on farmers who had been injured in the previous 1 year period and ignored the issue of multiple injuries among these farmers.

Several sleep related variables were constructed for the analyses to address the various dimensions of sleep deprivation and sleep related problems. The variables used were:

- Self reported average hours of daily sleep.
- Perceived sleep adequacy (enough or not enough).
- Use of medication (prescription or over the counter) in the past month to aid in sleep.
- Use of stimulant medication (prescription or over the counter, not including caffeine) in the past month.
- Signs of sleep apnea.

The presence of sleep apnea, using the signs of the disorder as proxies for the syndrome, was constructed based on the presence of three separate signs related to sleep apnea: snoring, gasping and snorting, and stopping breathing (Berkow, 1987). These variables were recoded to reflect an increasing probability of sleep apnea being present, and a categorical variable indicating the number of signs of the disorder was created.

Other sleep habits evaluated included:

- How often a participant farmed when sleepy.
- Whether farm or off farm work was performed without enough sleep in the past month.
- Whether the respondent had gone for 24 hours without sleep in the past month.

In addition to the primary exposure and outcome variables, important covariates were examined in relation to the risk of injury and included the age of the farmer, type of farm, educational level, annual farm income, and weekly hours worked at the off farm job.

Data Management and Analysis

Data from the Farm Health Interview Surveys were entered directly into a database using the computer assisted telephone interviewing system. Data management was performed using SAS software, and data were analyzed using SPSS Version 10.1.

The results of the categorical analyses, which were reported by specific demographic and sleep habit strata, identified the independent variables, which were significantly related to the incidence of injury. The independent variables were then examined using bivariate logistic regression with "injury versus no injury" as the outcome variable. These analyses resulted in the calculation of odds ratios [*OR*s] and 95% confidence intervals [*CI*s] for the various strata versus the variable stratum chosen to be the referent group. After associations of the outcome (injury versus no injury) and the independent variables outlined above were calculated, multivariate logistic regression was used to examine those variables that were plausible and found to be important in the analyses of the association of injury occurrence with the potential risk factors. This allowed estimation of the magnitude of the association between independent variables and the binary outcome of "injury versus no injury," after adjusting simultaneously for potential confounding factors.

RESULTS

Demographics

Table 1 presents demographics for the study sample. Mean age was 49 years, with 79% reporting a 12th grade education or higher. Annual farm income was less than or equal to $10,000 for two thirds of the farmers, and nearly half of the farmers (47%) reported cattle as their type of farm. Approximately half indicated they spent 31 to 40 hours a week in their off farm job, and 12% had suffered an injury in the past year that met the study criteria.

The mean for average hours of daily sleep was 7.6 hours, with 5.6% reporting 5 or less hours of sleep daily (see Table 2). For sleep apnea, 77% had at least one sign and 6.7% had all three signs. Approximately 26% reported not getting enough sleep, and 13% and 15% reported performing farm work and off farm work, respectively, without enough sleep in the past month. Nine percent had gone without sleep for 24 hours at least once in the past month, and 43% farmed once in a while or more often when sleepy. Slightly more than 5% had taken sleep medicine in the past month, whereas less than 1% had used a stimulant to stay awake during the same time period.

Injury Risk Factors

The distribution of injuries by demographic and sleep related variables is presented in Table 3. A total of 121 farmers reported injuries, yielding a crude rate of 12.1 injured farmers per 100 farmers over a 1 year period. Compared with the referent group of farmers older than age 60, who had the lowest injury rate at 7.8%, farmers age 31 to 40 demonstrated nearly double the injury rate at 14.8% (*OR* = 2.05, 95% *CI* = .93 to 4.53).

College educated farmers were more likely to be injured (*OR* = 1.48, 95% *CI* = .78 to 2.84) compared to the referent group of farmers with an 8th grade education or less. Overall, the college educated group had an injury rate 1.5 times that of the other three strata. Higher farm income (> $40,000) had a mildly mediating effect (*OR* = .46, 95% *CI* = .16 to 1.30) on injury incidence compared to the referent of farms with an annual income of less than $10,000; injury incidence was 5.7% in the former group and 11.6% in the latter group (referent). The $10,001 to $40,000 annual income group had an increased injury

Table 1

Demographic Characteristics of Male Part-Time Kentucky Farmers ($N = 1,004$)

Characteristic	n	%
Age (years)		
19 to 30	57	5.7
31 to 40	142	14.1
41 to 50	324	32.3
51 to 60	353	35.2
> 60	128	12.7
Education		
≤ 8th grade	120	12.0
9th to 11th grade	89	8.9
12th grade	461	45.9
Some college	334	33.2
Annual farm income		
≤ $10,000	629	62.6
$10,001 to $40,000	274	27.3
> $40,000	70	7.0
Missing	31	3.1
Type of farm		
Cattle	472	47.0
Crops	237	23.6
Crops and cattle	226	22.5
Other	60	6.0
Missing	9	.9
Weekly hours worked at off farm job		
≤ 30	124	12.3
31 to 40	490	48.8
41 to 50	258	25.7
> 50	103	10.3
Missing	29	2.9
Injury in past year		
Yes	121	12.1
No	883	87.9

incidence at 15% (*OR* = 1.34, 95% *CI* = .89 to 2.02). Farmers who worked 41 to 50 hours at an off farm job had an increased but insignificant injury rate (*OR* = 1.43, 95% *CI* = .73 to 2.80) compared to the referent group.

When considering sleep habits, those with ≤ 5 hours of sleep per day were at no higher risk of injury than the referent group with ≥ 8 hours per day. In fact, all levels of average hours of daily sleep had similar injury risks. Similarly, those who had missed sleep for 24 hours at least once in the past month did not have an increased risk of injury versus those in the group who had not. The perception of being sleep deprived showed a modest association with the risk of injury, with the group not getting enough sleep having a higher *OR* than the group getting enough sleep (1.29 versus 1.00, respectively).

Stimulant use did not increase risk of injury, but sleep medication use did. Among farmers who did not use sleep medication, 11.4% reported injuries compared with 22.6% for those who used it; this represented a twofold difference that was statistically significant (*OR* = 2.28, 95% *CI* = 1.16 to 4.47). Similarly, farmers with three signs of sleep apnea had a nearly twofold increased incidence of injuries versus those with no signs (19.4% versus 10.0%, respectively); this also achieved statistical significance (*OR* = 2.17, 95% *CI* = 1.03 to 4.56).

Farmers who performed farm work all or most times when sleepy had an injury incidence of 17.6% compared to 12.3% for those who never farmed when sleepy (*OR* = 1.53, 95% *CI* = .61 to 3.82). Farmers who performed farm work without enough sleep in the past month did not exhibit a significant increase in their risk for injury versus those who did not work without enough sleep. However, those working off the farm without enough sleep had a slightly increased, but not significant, risk versus the referent (*OR* = 1.37, 95% *CI* = .84 to 2.24).

Table 2

Sleep Characteristics of Male Part-Time Kentucky Farmers ($N = 1,004$)

Characteristic	n	%*
Average daily sleep in the past month (hours)		
≥ 8	326	32.5
7	428	42.6
6	188	18.7
≤ 5	56	5.6
Sleep apnea signs and symptoms		
None	230	22.9
One	523	52.1
Two	183	18.2
Three	67	6.7
Sleep perception		
Not enough	258	25.7
Enough	724	72.1
Farm work done without enough sleep in the past month		
Yes	127	12.6
No	868	86.5
Off farm work done without enough sleep in the past month		
Yes	151	15.0
No	836	83.3
Missed sleep for 24 hours in the past month		
Yes	89	8.9
No	915	91.1
How often farming is performed when sleepy		
All, most times	34	3.4
Sometimes	69	6.9
Once in a while	328	32.7
Never	569	56.7
Sleep medication used in the past month		
Yes	53	5.3
No	948	94.4
Stimulant used in the past month		
Yes	8	.8
No	995	99.1

**Percentages may not add to 100% because of missing values.*

The results of the bivariate logistic regression analyses were used to model the risk of injury in the multiple logistic regression analysis. Sleep medication use and sleep apnea were included in the main effects model along with the covariates of average reported daily sleep, farm type, educational level, and annual farm income. The results revealed a modest but non-significant trend for college educated farmers to have an increased occurrence of injuries ($OR = 1.87$, 95% $CI = .87$ to 4.04) compared to the referent of those with an 8th grade or lower education (see Table 4). An annual farm income of more than $40,000 had a modest protective effect for risk of injury ($OR = .41$, 95% $CI = .14$ to 1.17) compared to the referent.

No association was found between reported average daily sleep and risk of injury. Significant risk factors for injury occurrence were sleep medication use in the past month ($OR = 2.11$, 95% $CI = 1.01$ to 4.40) and the reported presence of all three signs of sleep apnea ($OR = 2.48$, 95% $CI = 1.13$ to 5.41).

DISCUSSION

More than three quarters of the Kentucky farmers in this sample who held off farm jobs reported getting an average of 7.6 hours of sleep daily. The 1 year cumulative incidence of injury was not found to be significantly associated with fewer hours of sleep, but there were other sleep patterns and demographic char-

Table 3

Bivariate Logistic Analysis of Potential Risk Factors for Injuries in Male Part-Time Kentucky Farmers (*N* = 1,004)

Risk Factor	*Farmers* n	*Injured Farmers* n	*Injury Rate** %	OR	*95%* CI
Age (years)					
19 to 30	57	7	12.3	1.65	.60 to 4.59
31 to 40	142	21	14.8	2.05	.93 to 4.53
41 to 50	324	39	12.0	1.62	.78 to 3.34
51 to 60	353	44	12.5	1.68	.82 to 3.45
> 60	128	10	7.8	1.00	—
Education					
⩽ 8th grade	120	13	10.8	1.00	—
9th to 11th grade	89	9	10.1	.93	.38 to 2.27
12th grade	461	48	10.4	.96	.50 to 1.83
Some college	334	51	15.3	1.48	.78 to 2.84
Type of farm					
Cattle	472	60	12.7	2.04	.71 to 5.82
Crops	237	33	13.9	2.26	.77 to 6.66
Crops and cattle	226	24	10.6	1.66	.55 to 4.99
Other	60	4	6.7	1.00	—
Annual farm income					
⩽ $10,000	629	73	11.6	1.00	—
$10,001 to $40,000	274	41	15.0	1.34	.89 to 2.02
> $40,000	70	4	5.7	.46	.16 to 1.30
Average daily sleep in the past year (hours)					
⩾ 8	326	37	11.3	1.00	—
7	428	49	11.4	1.01	.64 to 1.59
6	188	26	13.8	1.25	.73 to 2.15
⩽ 5	56	7	12.5	1.12	.47 to 2.64
Missed sleep for 24 hours in the past month					
Yes	89	9	10.9	.81	.39 to 1.65
No	915	112	12.2	1.00	—
Sleep perception					
Not enough	258	36	14.0	1.29	.85 to 1.96
Enough	724	81	11.2	1.00	—
Stimulant used in the past month					
Yes	8	1	12.5	1.05	.13 to 8.62
No	995	119	12.0	1.00	—
Sleep medication used in the past month					
Yes	53	12	22.6	2.28	1.16 to 4.47
No	948	108	11.4	1.00	—
Sleep apnea signs and symptoms					
None	230	23	10.0	1.00	—
One	523	69	13.2	1.37	.83 to 2.26
Two	183	16	8.7	.86	.44 to 1.69
Three	67	13	19.4	2.17	1.03 to 4.56

Table 3 (continued)

Bivariate Logistic Analysis of Potential Risk Factors for Injuries in Male Part-Time Kentucky Farmers (N = 1,004)

Risk Factor	Farmers n	Injured Farmers n	Injury Rate* %	OR	95% CI
How often farming is performed when sleepy					
All, most times	34	6	17.6	1.53	.61 to 3.82
Sometimes	69	6	8.7	.68	.28 to 1.63
Once in a while	328	39	11.9	.96	.63 to 1.46
Never	569	70	12.3	1.00	—
Farm work done without enough sleep in the past month					
Yes	127	19	15.0	.74	.44 to 1.26
No	868	100	11.5	1.00	—
Weekly hours worked at off farm job					
≤ 30	124	13	10.5	1.00	—
31 to 40	490	56	11.4	1.10	.58 to 2.09
41 to 50	258	37	14.3	1.43	.73 to 2.80
> 50	103	11	10.7	1.02	.44 to 2.39
Off farm work done without enough sleep in the past month					
Yes	151	23	15.2	1.37	.84 to 2.24
No	836	97	11.6	1.00	—

**Rate = number of injured farmers per 100 part-time farmers per year.*
OR = *odds ratio*, CI = *confidence interval.*

acteristics that showed strong associations with the incidence of injury.

The presence of all three signs of sleep apnea (reported by 6.7% of the total sample) resulted in more than a twofold increased risk of injury in the previous year compared with those who did not report any signs. When analyzed in the logistic regression model, this relationship continued to be significant. In the study, it was assumed that an increasing number of signs of sleep apnea was equivalent to an increased probability of the disorder being present or an increased severity of the disorder.

Previous studies in long haul truck drivers and nonprofessional motorists have revealed an increased incidence of motor vehicle crashes in those with sleep apnea (Findley, 1992; Stoohs, 1994). However, in this study, injury incidence in general (not limited to motor vehicle crashes) was increased in the group reporting the most signs of the disorder. The results support the relationship of sleep apnea to increased incidence of injury in the study population of Kentucky farmers who hold off farm jobs. The mechanism for the increased injury rate is hypothesized to be that of relative sleep deprivation resulting in increased daytime sleepiness with decreased attentiveness and a decreased ability to respond quickly and attend to stimuli (Findley, 1992; Guilleminault, 1994). Other injuries in this group may result simply from falling asleep at the wrong time (e.g., while driving an automobile or working with dangerous machinery).

Another risk factor found to be significantly associated with the occurrence of injury was the use of sleep medication. Although this group represented only 5% of the sample studied, in the bivariate analysis, sleep medication users were more than twice as likely to have had an injury in the past year as nonusers. While the use of sleep medication has been found to influence the severity of sleep apnea (Berkow, 1987), the association of sleep medication use with injury remained significant in this study ($p < .05$). It is possible that such medication, if it has a long half life, actually intensifies inattentiveness via a "hangover" effect the following day if taken too late before scheduled rising (Berkow, 1987). It also may be that this group has the most sleep related problems initially and that the need for sleeping pills is a symptom of the actual problem.

The group of farmers who spent 41 to 50 hours weekly at their off farm job were more likely to be injured than those who spent 30 hours or less weekly at their off farm job. However, the farmers reporting more than 50 hours a week at their off farm job had an injury incidence almost identical to the referent. These results are difficult to explain, but one potentially important piece of information (i.e., the number

Table 4

Multivariate Logistic Regression Analysis of Potential Risk Factors for Injuries in Male Part-Time Kentucky Farmers

Risk Factor	OR	*95% CI*	P *Value*
Education			
≤ 8th grade	1.00	—	—
9th to 11th grade	1.16	.43 to 3.13	.76
12th grade	1.35	.63 to 2.89	.44
Some college	1.87	.87 to 4.04	.11
Annual farm income			
≤ $10,000	1.00	—	—
$10,001 to $40,000	1.40	.91 to 2.15	.12
> $40,000	.41	.14 to 1.17	.10
Type of farm			
Other	1.00	—	—
Cattle	1.88	.65 to 5.44	.24
Crops	2.21	.74 to 6.64	.16
Crops and cattle	1.39	.46 to 4.28	.56
Average daily sleep in the past month (hours)			
≥ 8	1.00	—	—
7	.91	.57 to 1.46	.71
6	1.17	.67 to 2.04	.59
≤ 5	1.02	.42 to 2.46	.97
Sleep medication used in the past month			
No	1.00	—	—
Yes	2.11	1.01 to 4.40	.05
Sleep apnea signs and symptoms			
None	1.00	—	—
One	1.50	.89 to 2.54	.13
Two	.89	.44 to 1.81	.75
Three	2.48	1.13 to 5.41	.02

OR = *odds ratio*, CI = *confidence interval*.

of hours the farmer spent farming weekly) was not available from the telephone survey. It is important to consider the full burden of work when examining the risk for injury.

STRENGTHS AND LIMITATIONS

This study examined the injury experience of a targeted group of part-time male farmers age 19 and older. The study population was predominantly white (98.5%), and 79% had completed high school. While the results of this study should not be extended to all male farmers, migrant farmers, female farmers, or children, the researchers believe the sample of part-time male farmers in this study is generally representative of the population of male farmers in Kentucky who also work in other occupations while farming. While the data in these analyses were collected in 1994 to 1995, there have not been any studies in the literature that have addressed the association between sleep deprivation and the risk of injuries in farmers. Given that the proportion of farmers who hold employment outside of their farm work has increased over the past decade and reports have indicated that the population, in general, has been getting less sleep (National Sleep Foundation, 2002), the associations between the indicators of sleep deprivation and risk of injury may exist in a larger proportion of the current agricultural work force of bivocational farmers.

Past studies relating sleep deprivation to impairments in performance have considered populations such as long haul truckers, medical residents, military personnel, and pilots (Asken, 1983; Caldwell, 1997; Leung, 1992). Sleep apnea, another sleep related phenomenon, has been studied in its relationship to motor vehicle crashes in both professional and nonprofessional motorists (Findley, 1992; Stoohs, 1994). The possibility of recall bias by the farmers reporting injuries in this study with both the risk factors and the injury incidence data collected at the same time is a potential limitation. That is, because injuries were self reported, the occurrence of an injury may have made the participant more likely to remember potential risk factors. Another poten-

tial problem was the possible failure of the participants to recall injuries, which would result in the underestimation of injury rates. Factors such as the elapsed time between the injury and the interview also may have affected recall.

The chosen time frame for reporting sleep habits was the previous month. The use of these data assumes the farmers' sleep habits are constant throughout the year. This is almost certainly not the case, as at certain times of the year, such as during harvesting, heavier workloads dictate fewer hours of sleep. Within this study, it was not possible to relate the occurrence of injury to the exact nights, for example, when sleep was missed completely. Other study designs, such as those employing a case crossover approach, improve the ability of investigators to assess the etiologic relationship between sleep disorders and the risk of injury, while accounting for time dependent covariates (Lombardi, 2003; Mittleman, 1997; Sorock, 2001a, 2001b).

Defining sleep deprivation was another problem faced in the study in that there are individual differences in sleep need. The universally accepted amount of sleep representing "a good night's sleep" is 8 hours per night (National Sleep Foundation, 2002). A further limitation exists in using the signs of snoring, gasping during sleep, and temporary cessation of breathing during sleep as proxies for sleep apnea. Although these symptoms have been shown to be present in many with obstructive sleep apnea, there are individuals with the syndrome who do not display these signs and, conversely, individuals with the signs who do not necessarily have the syndrome (Berkow, 1987).

Finally, the information on hours per week spent farming was not available for this analysis. This lack of exposure time precluded the calculation of person-time rates in the study. If the information had been available related to hours spent farming weekly, the study results could have been compared to previous studies that have related hours spent farming to the occurrence of injuries.

PREVENTING INJURIES RESULTING FROM SLEEP DEPRIVATION

The causal models for most injuries recognize that injuries result from a complex interaction of physical, social, economic, cultural, and demographic features (Peek-Asa, 2003). Sleep deprivation may be an indicator of other factors (e.g., stress, chronic illness) or the result of sleep disorders, work, or lifestyle factors that result in sleep that is insufficient for the body's needs. The key issues in developing a strategy for the prevention of injuries that may be related to inadequate sleep or a sleeping disorder is the proper diagnosis of the sleep related problem for individual farmers and the development of population level interventions (e.g., educational programs, policy changes) that are focused on these concerns for the agricultural community, health providers, and employers.

This study reported a small percentage of part-time farmers used sleep medications (5.3%) or had three signs or symptoms of sleep apnea (6.7%). This group of farmers had a twofold increased risk for injuries. This suggests there are a small group of workers with sleep disorders such as sleep apnea, nocturnal myoclonus, or narcolepsy who need to seek the assistance of health care providers. Occupational health nurses, physicians, and health care providers need to question clients about the symptoms of sleep disorders such as snoring, gasping, snorting, stopping breathing, morning headache, and daytime fatigue in determining whether sleep deprivation may be caused by a sleeping disorder. In the case of sleep apnea, sedative hypnotics also should be avoided, and the use of continuous positive airway pressure will help significantly with daytime hypersomnolence (Findley, 1992; Kribbs, 1993). Sleeping problems also may be caused by chronic health conditions (e.g., asthma, congestive heart failure, stress, depression) or substance use, which can be assessed as part of the clinical examination.

More than one in four farmers in this study (26%) perceived that they did not receive enough sleep; 67% reported they slept 7 hours or fewer per day in the past month. While those who perceived they did not have enough sleep were at slightly increased risk for an injury, the increase was not significant. Sleep deprivation, which is not related to a sleep disorder, may be related to difficulty in falling asleep at night or inadequate allowance of time for sleep because of work or lifestyle factors. Numerous approaches exist to alleviate the potential dangers associated with daytime sleepiness and the attendant decrease in performance, which may be related to inadequate sleep. Farmers often perform business and financial tasks in the evening hours prior to sleeping, which may be associated with stress and worry. Alternative times for scheduling these tasks may be useful counsel to farmers. Studies with airplane pilots have looked at strategies such as self administered relaxation therapy, consistent and soothing bedtime routines, and avoidance of alcohol and caffeine immediately prior to sleep (Caldwell, 1997). The importance of scheduling time for restorative, relaxing activities needs to be emphasized as it can increase overall productivity and satisfaction with work.

Periods of prolonged work, especially during peak planting and harvest times, are part of the job for farmers. Bivocational farmers often work 30 to 40 hours per week in their off farm job and devote an additional 20 to 40 hours in performing their farm work. Unlike in industry, the monitoring of their total work hours are not proscribed by labor regulations, and rest breaks are not required. The results in this study are substantiated by findings by Dong (2002) who reported working overtime was significantly related to work related injuries for construction workers. When opportunities for adequate sleep are not available because of work related factors, prophylactic naps can sustain performance until sleep is possible (Caldwell, 1997). It is known that most injuries occur in the early morning hours and in the mid afternoon, which may be partially a consequence of normal circadian rhythms (Folkard, 2004). Scheduling of work tasks to avoid the most hazardous tasks during these times may be useful. Rest breaks of a duration of at least 15 minutes and adequate time for meals are important in reducing work related fatigue. At times of predictable peak farm work, such as planting and harvest, off farm supervisors may schedule farmers for shorter work days to reduce the farmers' total workload and allow more time for sleep.

OCCUPATIONAL HEALTH NURSING IMPLICATIONS AND FUTURE DIRECTIONS

Targeting a potentially high injury risk subgroup of farmers, namely, those who may have signs of sleep apnea or indicate they are taking sleep medications, is an important implication of the findings in this study. Farmers with sleep disorders may be at an increased risk for injuries. Appropriate interventions by health care professionals in ameliorating the sleep deprivation related to an existing sleep disorder need to be addressed for individual farmers with these conditions.

Additional research should focus on approaches that allow and encourage farmers to get adequate rest, especially during high demand periods of farm work. Interventions should address approaches that allow farmers to reduce their other commitments, both off farm work and social, during these periods or secure additional labor to make adequate rest a priority. Educational interventions should emphasize the self detection of signs of inadequate or disordered sleep, the significance of appropriate nutrition and breaks, the importance of scheduling hazardous tasks following periods of adequate rest, caution in the use of over the counter sleep medications, and the importance of seeking professional assistance with sleep disorders in reducing injury risk for farmers who hold off farm jobs.

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