



## Occupational safety: The role of workplace sleepiness

Sarah DeArmond <sup>a,\*</sup>, Peter Y. Chen <sup>b</sup>

<sup>a</sup> College of Business, University of Wisconsin Oshkosh, 800 Algoma Boulevard, Oshkosh, WI 54901, United States

<sup>b</sup> Occupational Health Psychology and Industrial-Organizational Psychology, Department of Psychology, Colorado State University, Fort Collins, CO 80523, United States

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### ABSTRACT

Workplace sleepiness refers to how sleepy a person feels at work, and it is thought to be associated with negative occupational safety outcomes such as injuries because sleepiness can lead to behavioral decrements at work. This study explored safety behavior as a mediator of the relationship between workplace sleepiness and occupational safety outcomes (e.g., occupational injuries). A survey was conducted on certified nursing assistants working in long term care facilities. The Stanford Sleepiness Scale was used to measure workplace sleepiness. Occupational injuries were assessed in multiple ways: injury frequency, injury severity, pain frequency, pain severity-duration, and pain severity-intensity. This study provided support for a negative relationship between workplace sleepiness and safety behavior and limited support for a positive relationship between workplace sleepiness and occupational injuries. Workplace sleepiness was significantly related to pain frequency and pain severity (as indexed by both duration and intensity); however, it was not significantly related to injury frequency or severity. The results of the study also suggest very limited support for safety behavior as a mediator of this relationship. The findings suggest that the relationship between workplace sleepiness and occupational injuries might be more complex than originally assumed.

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## 1. Introduction

Occupational safety is, and should be, a major concern for organizations and society as a whole. Data from the United States Bureau of Labor Statistics (USBLS) show that among private industry employers in the United States there were 4.4 cases of nonfatal occupational injuries and illnesses per 100 equivalent full-time workers in 2006 (USBLS, 2007b). In the same year the USBLS recorded 5703 fatal work injuries (USBLS, 2007a). While these numbers reflect a decrease in occupational injuries and illnesses from previous years, there is still cause for concern. The costs associated with occupational injuries and illnesses are extremely high. One study estimated the financial costs in the United States to be over a hundred billion dollars (Leigh et al., 2000). Hence, there is a need for continued research aimed at identifying factors which may play a role in occupational safety. The current study focuses on one such factor, workplace sleepiness.

Workplace sleepiness refers to how sleepy a person is at work (DeArmond and Chen, 2007). There are two forms of workplace sleepiness. The first is physiological in nature and refers to how sleepy someone is from a physiological perspective. Physiological workplace sleepiness is a function of sleep quotas and one's inter-

nal biological clock. The second form is subjective in nature. While subjective workplace sleepiness is influenced by one's physiology it is also influenced by other factors such as work environment, task characteristics, and motivation. The current study will focus on the latter form of workplace sleepiness.

Workplace sleepiness does not receive frequent attention in organizational research; however, the notion of a connection between sleep-related issues and occupational safety is not new. For instance, more than 90% of the respondents to the 2002 National Sleep Foundation (NSF) (1998–2002) poll conducted in the United States believed that work performance and safety were influenced by deficits in sleep. Similarly, when there is discussion of sleep and safety in research literature, references frequently are made to the 1986 Chernobyl nuclear power plant accident, the 1979 Three Mile Island nuclear power plant accident, or the 1989 Exxon Valdez oil spill. All of these catastrophes were found to be the result of human error occurring during peak hours of sleepiness (midnight to 6 am) (Folkard and Lombardi, 2006).

Despite recognition of a link between workplace sleepiness and occupational safety, there is little field research that has specifically measured workplace sleepiness and directly examined its critical role in predicting occupational safety (Krauss et al., 2003). Therefore, the current study measured workplace sleepiness in a sample of healthcare workers and explored its relationships with two occupational safety outcomes: safety behavior and occupational injuries. Both are discussed in subsequent sections. Since

\* Corresponding author. Tel.: +1 9204247192; fax: +1 9204247413.

E-mail address: [dearmons@uwosh.edu](mailto:dearmons@uwosh.edu) (S. DeArmond).

there has been fairly little research which has looked at workplace sleepiness, readers should be aware that a great deal of the previous research we used to help formulate our hypotheses focuses on variables which are likely related to workplace sleepiness (e.g., sleep quality, sleep quantity, general sleepiness, sleep deprivation, fatigue). We have used research on these types of variables due to evidence that there is a relationship between these variables and sleepiness (Carskadon and Dement, 2000; Pilcher et al., 1997, 2003, 2000; Rogers et al., 1993).

### 1.1. Safety behavior

Safety behavior is a specific type of job behavior that promotes the health and safety of workers, clients, the public, and the environment (Burke et al., 2002; Griffin and Neal, 2000; Hofmann et al., 2003). Burke et al. and Hoffman et al. have suggested that safety behavior involves activities such as communicating information to others (e.g., making people aware of potentially dangerous situations), planning (e.g., taking proper safety precautions before and during work in a dangerous situation), and engaging in monotonous tasks (e.g., checking and rechecking safety equipment to ensure that it is in good working order).

There is substantial research to date suggesting that workplace sleepiness might be related to safety behavior. For instance, there is evidence which links sleepiness-related variables to decrements in communication (Harrison and Horne, 2000), planning (Babkoff et al., 1985; Blagrove and Akehurst, 2001; Bugge et al., 1979; Harrison and Horne, 2000; Wallace et al., 2003), and problems engaging in monotonous tasks (Englund et al., 1985; Gillberg and Akerstedt, 1998; Gillberg et al., 1994; Mertens and Collins, 1986). There is also support for the notion that increases in workplace sleepiness might be connected to decrements in skills and motivation, which are major determinants of behavior at work (Campbell et al., 1993). With regard to skill, there is empirical evidence which supports a negative relationship between workplace sleepiness and problem solving skills (Harrison and Horne, 2000; Mertens and Collins, 1986) and also logical reasoning skills (Blagrove and Akehurst, 2001; Wallace et al., 2003). With regard to motivation there is evidence to suggest that increases in workplace sleepiness are associated with decreases in effort (Engle-Friedman et al., 2003).

These findings have been explained two ways typically. First, it is thought that some decrements in behavior are the result of what are called microsleeps. Microsleeps are 1–10 s periods in which a person slips into Stage 1 sleep while still appearing to be awake (Roehrs et al., 2000). This could be particularly problematic in work settings because when people fall into Stage 1 sleep, they do not typically report being asleep, yet their reactions to outside stimuli are diminished (Moorcroft, 1993). When someone has entered Stage 1 sleep, he/she can easily be awoken; however, electroencephalogram and electromyogram activity clearly indicates that the person sleeping.

Second, it has been suggested that the brain functions less efficiently when experiencing sleep deprivation, which can cause sleepiness. Research has linked sleep deprivation to decreased functioning in parts of the brain important for attention, arousal, higher order analysis and integration of sensory-motor information, cognition, language processing, and learning (Drummond and Brown, 2001; Thomas et al., 2000). Deficits in these functions could clearly lead to decrements in behavior at work including safety behavior.

Given these empirical findings in conjunction with the rationale for them, it seems likely that workplace sleepiness and safety behavior are negatively related; however, the research in this area has had limitations. First, studies supporting a connection between sleepiness and safety behavior often do not measure workplace sleepiness. Most measure some type of sleepiness-related variable (e.g., sleep quality, sleep quantity, fatigue, etc.). Second, studies that

do measure workplace sleepiness (Bonnet and Arand, 2005; Engle-Friedman et al., 2003; Gillberg et al., 1994; Rosa and Colligan, 1988) often are conducted in laboratory settings with low realism and external generalizability. Therefore the first objective of the current study was to conduct a field study which explored the following hypothesis:

**Hypothesis 1.** There is a negative relationship between workplace sleepiness and safety behavior.

### 1.2. Occupational injuries

Another indicator of occupational safety is the occurrence of injuries. As was the case with safety behavior, a number of research findings indirectly suggest a relationship between workplace sleepiness and occupational injuries. This research can be split into two major streams. The first consists of studies that have demonstrated a relationship between sleepiness or sleepiness-related variables (e.g., difficulty sleeping, sleep quantity, fatigue) and occupational injuries (Akerstedt et al., 2002; Gabel and Gerberich, 2002; Lilley et al., 2002; Nakata et al., 2005; Simpson et al., 2005). The second is based on studies that substantiate a relationship between sleep disorders and occupational injuries (Chau et al., 2004, 2002; Ulfberg et al., 2000). Sleep disorders are thought to be related to workplace sleepiness because people with sleep disorders tend to experience increased sleepiness during waking hours (Hossain et al., 2005). These two streams of research suggest a positive relationship between workplace sleepiness and occupational injuries.

Despite this consistent support in the above research, two limitations to this research should be noted. First and foremost, none of the research above specifically measures workplace sleepiness, and there is a very limited body of research which explores associations between general sleepiness and occupational injuries (Melamed and Oksenberg, 2002). While it is quite possible that general sleepiness and workplace sleepiness are related, they should not be conceptualized as the same construct. How sleepy a person is can be influenced by what he/she is doing (e.g., engaging in tasks that are monotonous), his/her environment (e.g., temperature), or diet (e.g., consumption of stimulants). One's tasks, environment, and diet can be different at work than home. For instance, someone who did not get much sleep might have a tendency to feel sleepy at home where he/she has fairly little to do yet alert at work because his/her work is dynamic and stimulating.

To address the above concern, the second objective of the current study was to explore the connection between workplace sleepiness and occupational injuries. Following the logic behind **Hypothesis 1**, we propose the following hypothesis:

**Hypothesis 2.** There is a negative relationship between workplace sleepiness and occupational injuries.

### 1.3. Safety behavior as a possible mediator

Much of the existing literature that explores the connection between sleepiness-related variables and occupational injuries has suggested that the relationship may be mediated by job behavior (Chau et al., 2002; Melamed and Oksenberg, 2002). It seems logical to expect that an increase in workplace sleepiness would be related to decrements in safety behavior, and that these decrements might be in part responsible for outcomes such as occupational injuries (Hofmann and Stetzer, 1996; Reber et al., 1993). Despite this, there is no known research which explores this pattern of relationships. Thus, the third objective of the current study is to explore safety behavior as a mechanism underlying the relationship between workplace sleepiness and occupational injuries. Thus, we hypothesize that...

**Hypothesis 3.** Safety behavior mediates the relationship between workplace sleepiness and occupational injuries.

## 2. Methods

### 2.1. Participants and procedure

According to the Occupational Information Network (ONET, 2008) certified nursing assistants (CNAs), "provide basic patient care under the direction of nursing staff (31-1012.00 – Nursing Aides, Orderlies, and Attendants)." CNAs groom, feed, dress, and move patients. They are also often involved with cleaning rooms (e.g., changing linens, emptying bed pans), dressing wounds, and collecting specimens (e.g., urine, feces).

CNAs were a good choice for this study given the focus on safety. In both 2003 and 2004, nursing aides, orderlies, and attendants represented the occupation with the third greatest number of occupational injuries and illnesses involving days away from work (Bureau of Labor Statistics, 2005). Further, the National Institute for Occupational Safety and Health (2005) has reported that there have been increases in occupational injuries and illnesses in the healthcare industry. This is cause for concern because this industry is growing and many of the other most hazardous industries have actually seen decreasing numbers of injuries and illnesses in the past decade.

At the beginning of the current study, three focus groups were conducted, with six or seven CNAs in each. Each CNA was paid \$20 for participating in the focus group. Focus group participants helped to generate and revise survey questions to assure relevance and clarity.

Once the survey content was finalized, participants were recruited from their places of employment. While management at these facilities acknowledged knowing about the study and encouraged CNAs to participate, involvement in the project was voluntary. A memo from the management team of the specific facility in conjunction with a cover letter from the research team was used to announce the purpose and process of the study. This memo was circulated using the typical intra-office communication methods employed by the participating facilities (e.g., memorandum in the appropriate employees' mailboxes). Posters were also posted in the facilities announcing information about the study. CNAs who were interested in participating in the study were asked to report to a designated area in each facility after their shifts on specific dates. There were no exclusion criteria for the study beyond having the job title of CNA. When the participants arrived at the designated area they were given more information about the study so they could make an informed decision about whether they were interested in participating. Those who agreed to participate, were then given a paper-and-pencil survey. Each CNA was paid \$5 for participating in the study. CNAs were paid less for participating in the survey than the focus group session because survey completion took less than half the time of focus group participation.

The sample for the current study consisted of 143 certified nursing assistants (CNAs) working for eight long term care facilities in the Rocky Mountain region of the United States. There were a total of 388 CNAs at the eight long term care facilities, which means that approximately 37% of the population participated in the surveys.

Of the 143 participants, 91.6% were women, and 84.9% were Caucasian, 10.8% were Hispanic, and 2.2% were African American (the remainder consisted of approximately equal parts Asian-Pacific Islanders and multiracial people). The sample's mean age was approximately 30 years old. The mean number of years that the sample had been working as CNAs was 5.3 and the mean tenure at the facilities was 2.3 years. Of the 143 CNAs, 7.0% reported that their highest level of education was some high school, 24.0% a high school diploma/GED, 10.1% some trade/technical school, 7.0% completion

of trade/technical school, 36.4% some college/university, 13.2% a bachelor's degree, and 2.3% some graduate school. The mean hours worked per week by these CNAs was 39.1.

### 2.2. Measures

Workplace sleepiness, safety behavior and occupational injuries were assessed in the present study and the measures used are detailed below. Participants were also asked to report the shift they work (1 = First/Morning, 2 = Second/Afternoon, 3 = Third/Night, 4 = Rotating). Shift was used as a control variable because it has been shown to be related to sleepiness (Dawson and Fletcher, 2001; Hurrell and Colligan, 1986) and occupational safety (Akerstedt, 1995; Bohl and Tilley, 1993; Folkard and Monk, 1979; Harrington, 1994).

#### 2.2.1. Workplace sleepiness

Workplace sleepiness was measured using the Stanford Sleepiness Scale (SSS) (Hoddes et al., 1973). This measure has proven reliable (Hoddes et al., 1972) and valid (Pilcher et al., 2003). The scale was also chosen because it measures the internal state of subjective sleepiness rather than a subjective estimate of sleep propensity like other scales such as the Epworth Sleepiness Scale (Pilcher et al., 2003; Johns, 2000). A slight wording change was made to make the language used in the response options more appropriate for the participants' reading levels. Participants were asked to choose one of the seven statements on the SSS that best described their typical sleepiness at work during the 2 weeks prior to survey administration. The directions to the SSS were adjusted for this study to assess sleepiness over the past 2 weeks rather than current sleepiness. Different reference periods have been used for sleepiness measures (Pilcher et al., 2003). There is also some evidence to support stability in workplace sleepiness across time. DeArmond and Chen (2007) conducted a study in which workplace sleepiness was measured using the SSS everyday for four days. There were strong correlations across time ( $r = .48–.66$ ). A 2-week time period was selected because it was short enough that people would still likely recall their typical level of sleepiness. In addition, this time frame was aligned with that used for the occupational injury measures. A 2-week recall period is within the range that has been recommended for assessing occupational injuries (Massey and Gonzales, 1976; Warner et al., 2005). This is explained further in the section describing the measurement of occupational injuries. Response options ranged from "Feeling active and vital; alert; wide awake" to "In a daze; sleep onset soon; lost struggle to remain awake."

#### 2.2.2. Safety behavior

A measure of safety behavior developed by Krauss et al. (2006) was employed. Krauss et al. (2006) created a 10-item safety behavior measure based on the General Safety Survey (GSS) (Burke et al., 2002) and the safety citizenship behavior scale (SCB scale) (Hofmann et al., 2003). Krauss et al. based this measure on the GSS and SCB, because it has been recognized that this is a multidimensional construct consisting of both required (task behaviors/safety compliance) and discretionary behaviors (citizenship behaviors/safety participation) (e.g., Griffin and Neal, 2000). The GSS was designed as a 27-item measure tapping four different types of safety task behaviors: using personal protective equipment, engaging in work practices to reduce risk, communicating health and safety information, and exercising employee rights and responsibilities. The SCB was designed as a 27-item measure which assesses six different types of safety citizenship behaviors: helping, voice, stewardship, whistle-blowing, maintaining up-to-date knowledge of safety issues, and initiating safety-related workplace change.

A 54-item measure of safety behavior is not practical in most field research. Therefore, Krauss et al. (2006) reduced the length of the measure based on the guidelines for measure reduction outlined by Stanton et al. (2002). The shortened measure created by Krauss et al. taps all 10 types of safety behavior with one item per dimension (e.g., using personal protective equipment: used the appropriate personal protective equipment as indicated by the site health and safety plan; helping: assisted others to make sure they performed their work safely.). This measure has proven to be reliable (internal consistency reliability, Cronbach's  $\alpha = .87-.90$ ) and valid in prior research (Krauss et al., 2006; Smith et al., 2006).

In the current study, participants were asked how frequently they had engaged in each behavior in the past 2 weeks. For instance, they were asked how often they had used the appropriate personal protective equipment when necessary, as indicated by the site health and safety plan. They responded using a six-point scale ranging from sometimes (1) to always (6). Scale scores were created by averaging item ratings. These anchor descriptions were selected to reduce the likelihood of negatively skewed response distributions which are typically found in the performance appraisal research literature. Ratings made using scales with symmetrical response anchors (i.e., never to always) tend to be less variable and more lenient than ratings made using skewed anchors (i.e., sometimes to always) (Cardy and Dobbins, 1994). The internal consistency reliability for this measure was adequate,  $\alpha = .85$ .

### 2.2.3. Occupational injuries

The occupational injuries measure consisted of a list of 15 occupational injuries (e.g., strains, punctures, bruises/contusions) developed from feedback from focus group participants, empirical research (e.g., Barling et al., 2003; Krauss, 2004), and information from the USBLS (2006), the National Institute for Occupational Safety and Health (NIOSH) (2005), and the American Nurses Association (ANA) (2005). In addition, a pain scale was included because the focus group participants, USBLS, ANA, and NIOSH have noted the prevalence of low back and other types of pain experienced by health professionals. The pain items were taken from the Standardized Nordic Questionnaire (Kuorinka et al., 1987), which has been used successfully in several worker populations (Baron et al., 1996; Goldsheyder et al., 2002; Merlino et al., 2003; Rosecrance et al., 2002). Both injuries and pain were assessed along two dimensions: frequency and severity.

For the injury items, participants were asked to report whether they had experienced each of the occupational injuries in the past 2 weeks, and if so, whether they took time off work because of the injuries. They responded using a seven-point scale ranging from 1 (No, I did not have this injury) to 7 (Yes, I took three or more days off). Injury frequency was calculated by summing all of the injuries each participant reported, regardless of the amount of time taken off work. Injury severity was calculated by summing the numeric responses pertaining to the amount of time taken off work across all the injuries (Carrivick et al., 2005; Collins et al., 2004; Horwitz and McCall, 2004).

For the pain items, participants were asked if they had experienced work-related pain in each of eight body areas (e.g., feet, upper back, low back, wrists/hands), and if so, how long the pain lasted. They responded using a seven-point scale ranging from 1 (No, I did not have pain in this area) to 7 (Yes, for four or more days). Frequency of pain was calculated by summing the number of instances of pain experienced, regardless of duration.

Pain severity was assessed in two different ways: as a function of pain duration and pain intensity (Bolton, 1999; Centers for Disease Control and Prevention, 2006; Tait and Chibnall, 2005). Pain duration was calculated by summing the numeric responses to the scale provided above. Pain intensity was assessed by again presenting the participants with the eight body areas and then asking them to rate

each on a seven-point scale ranging from "I did not have pain in this area" to "Unbearable pain." Pain intensity was calculated by summing responses to this numeric scale.

A 2-week time period for injury recall was chosen based on the recommendations of Massey and Gonzales (1976) and Warner et al. (2005). There are two major concerns when choosing a recall period for injury research. First, a recall period needs to be long enough to allow for injuries to have occurred. Second, a recall period needs to be short enough that people are able to remember the injuries that they have experienced. Massey and Gonzalez and Warner et al. have compared the accuracy of injury memories over different recall periods while taking this first concern into account. Their research findings led them to suggest recall periods of 2–4 or 3–6 weeks as the best balances of these two concerns. Furthermore, a number of studies on injury recall have noted that shorter recall reference periods are better for less severe injuries (Landen and Hendricks, 1995; Warner et al., 2005). According to information gathered in focus group sessions, CNAs face a great deal of minor injuries such as bruises/contusions, strains, or minor cuts.

## 2.3. Analyses

To examine **Hypotheses 1 and 2** (i.e., workplace sleepiness is related to safety behavior and occupational injuries), partial correlations were calculated by controlling for shift. To examine if safety behavior mediates the relationship between workplace sleepiness and occupational injuries, the Baron and Kenny (1986) approach was employed. According to Baron and Kenny, three criteria must be met in order for a mediation hypothesis to be upheld. First, the independent variable (workplace sleepiness) must be a significant predictor of the mediator (safety behavior). Second, the independent variable must be a significant predictor of the dependent variable. Third, the mediator should be a significant predictor of the dependent variable (injury frequency, injury severity, pain frequency, pain severity-duration, or pain severity-intensity) after controlling for the effect of the independent variable. In addition, the effect of the independent variable on the dependent variable should be lessened after accounting for the effect of the mediator. Pearson product-moment correlations were used to test the first two criteria. The third criterion was tested using hierarchical regression. Shift dummy variables and workplaces sleepiness were entered as predictors in the first step of the analysis and safety behavior in the second.

Although widely used, the Baron and Kenny (1986) method for assessing mediation has been criticized (MacKinnon et al., 2002). One of the major criticisms of this method is that while it establishes conditions for mediation, it never really tests the indirect effect of the independent variable on the dependent variable through the mediator (referred to as the intervening variable effect). Other tests have been developed to test the intervening variable effect. Perhaps the most widely used is that created by Sobel (1982). If all the criteria outlined by Baron and Kenny (1986) were met in this study, a variant of the Sobel method for testing the intervening variable effect was used. This variant was devised by MacKinnon et al. (1998) and is referred to as the empirical distribution of  $z' = \alpha\beta/\sigma_{\alpha\beta}$  (where  $\alpha$  = regression coefficient associated with regressing the mediator on the independent variable,  $\beta$  = regression coefficient associated with regressing the dependent variable on the mediator, and  $\sigma_{\alpha\beta}$  = standard error of the intervening variable effect  $-\alpha\beta$ ). The Sobel test involves the calculation of a  $z$ -statistic. This alternative method involves the same calculation, but the statistic is referred to as  $z'$  instead of  $z$ . This is because the statistic is compared against a distribution created by MacKinnon et al. (1998). The critical value for the .05 significance level for this distribution is .97 instead of 1.96.

**Table 1**

Descriptive statistics, Pearson product-moment, and partial correlations for all variables included in the analyses.

Variable	Possible range	Obtained range	Mean	S.D.	1	2	3	4	5	6	7
1. Sleepiness	1–7	1–6	2.504	1.224	-.205*	.074	.055	.318*	.350*	.354*	
2. Safety behavior	10–60	18.89–60	42.427	10.626	-.194*	-.060	-.045*	-.291*	-.136	-.129	
3. Injury frequency	0–15	0–7	1.343	1.464	.071	-.136	.728*	.422*	.327*	.386*	
4. Injury severity	0–105	6–28	16.321	2.264	.053	-.089	.732*	.379*	.349*	.430*	
5. Pain frequency	0–8	0–8	3.161	2.440	.305*	-.313*	.435*	.388*	.811*	.781*	
6. Pain severity (duration)	0–56	2–53	17.021	10.886	.339*	-.158	.346*	.357*	.814*	.808*	
7. Pain severity (intensity)	0–56	4–44	17.242	8.027	.343*	-.128	.376*	.424*	.778*	.809*	

Notes: S.D., standard deviation; listwise deletion was used; values below the diagonal represent Pearson product-moment correlations,  $N=126$ ; values above the diagonal represent partial correlations with shift used as a control variable,  $N=125$ .

\*  $p<.05$ .

### 3. Results

Descriptive statistics (i.e., possible and obtained range of scale scores, means, and standard deviations) and both Pearson product-moment correlations (below the diagonal) and partial correlations (controlling for shift) are provided in Table 1. Listwise deletion was used. As can be seen in this table even after controlling for shift worked, workplace sleepiness was significantly correlated with safety behavior such that high levels of workplace sleepiness were associated with low levels of safety behavior. This result provides support for the first hypothesis. With regard to the second hypothesis, workplace sleepiness was significantly related to pain frequency, pain severity-duration, and pain severity-intensity even after controlling for shift worked. The correlations were positive as expected—high levels of workplace sleepiness were associated with high levels in each of these variables. Given that there were only significant correlations between workplace sleepiness and some of the indicators of occupational injury (i.e., pain frequency, pain severity-duration, and pain severity-intensity), the second hypothesis was only partially supported. It is also notable that the range of observed injury frequency and severity scores seems restricted given the possible range of scores.

The support for the first hypothesis provides support for the first criterion for mediation outlined by Baron and Kenny (1986): the independent variable must be a significant predictor of the mediator. The partial support for the second hypothesis provided partial support for the second criterion of mediation outlined by Baron and Kenny: the independent variable must be a significant predictor of the dependent variable(s). After controlling for shift worked, workplace sleepiness was only a significant predictor of pain frequency, pain severity-duration, and pain severity-intensity. Results for tests of the third criterion can be seen in Table 2. After controlling for the effect of shift and workplace sleepiness, safety behavior

was a significant predictor only of pain frequency. The size of the standardized regression coefficient for workplace sleepiness produced in the first step of the regression analysis involving pain frequency was compared to that produced in the second step. The results showed that the third criterion was met for pain frequency. The  $z$  statistic (MacKinnon et al., 1998) showed that the intervening variable effect was significant ( $z'=2.05$ ,  $p<.05$ ). Overall, the above results suggest that safety behavior may mediate the relationship between workplace sleepiness and pain frequency. This provides only very limited support for the third hypothesis.

### 4. Discussion

#### 4.1. Relationships between workplace sleepiness and occupational safety

It provided support for a negative relationship between workplace sleepiness and safety behavior and a positive relationship between workplace sleepiness and pain frequency and pain severity (as indexed by both duration and intensity). However, workplace sleepiness was not significantly related to injury frequency or severity.

The connection between sleep and pain is not surprising. This study's results are consistent with prior research which supports a relationship between these two variables. A majority of research on the connection between sleep and pain suggests that there is a bidirectional relationship between the two variables (Affleck et al., 1996; Modolfsky, 2001; Raymond et al., 2004). Sleep deprivation actually causes hyperalgesia or an increased sensitivity to pain (Kundermann et al., 2008; Lautenbacher et al., 2006; Nascimento et al., 2007; Smith et al., 2005). Pain can also delay sleep onset, disrupt sleep once it is in progress, and increase the likelihood of awakening early (Modolfsky, 2001). Therefore, the positive relationships

**Table 2**

Tests of the third criterion for assessing the mediation hypothesis.

	Injury frequency		Injury severity		Pain frequency		Pain severity-duration		Pain severity-intensity	
	B( $\beta$ )	SE	B( $\beta$ )	SE	B( $\beta$ )	SE	B( $\beta$ )	SE	B( $\beta$ )	SE
<b>Step 1</b>										
Shift dummy 1	.929 (.293)*	.288	.105 (.021)	.473	.621 (.118)	.480	2.488 (.106)	2.153	1.266 (.072)	1.640
Shift dummy 2	.868 (.255)*	.310	.994 (.186)	.508	.865 (.153)	.515	3.460 (.136)	2.310	1.400 (.076)	1.726
Shift dummy 3	1.114 (.144)	.658	.960 (.079)	1.076	-.392 (−.030)	1.094	−2.907 (−.050)	4.893	−5.249 (−.127)	3.578
Sleepiness	.151 (.126)	.099	.010 (.005)	.162	.587 (.295)*	.165	2.767 (.311)*	.737	2.344 (.350)*	.566
<b>Step 2</b>										
Shift dummy 1	.901 (.285)*	.294	.047 (.010)	.482	.395 (.075)	.477	2.123 (.090)	2.188	1.032 (.059)	1.680
Shift dummy 2	.827 (.242)*	.320	.907 (.170)	.525	.527 (.093)	.520	2.910 (.115)	2.383	1.096 (.059)	1.788
Shift dummy 3	1.064 (.137)	.666	.855 (.071)	1.089	−.800 (−.062)	1.081	−3.575 (−.062)	4.945	−5.624 (−.137)	3.628
Sleepiness	.139 (.117)	.102	−.015 (−.008)	.167	.490 (.246)*	.165	2.608 (.293)*	.756	2.263 (.338)*	.580
Safety behavior	−.006 (−.046)	.012	−.013 (−.063)	.019	−.049 (−.226)*	.019	−.082 (−.084)	.086	−.044 (−.061)	.065
N	135		134		135		134		125	

Notes: B, unstandardized regression coefficient;  $\beta$ , standardized regression coefficient; SE, standard error.

\*  $p<.05$ .

between workplace sleepiness and pain frequency and severity are consistent with previous research. Yet, the lack of a relationship between workplace sleepiness and injury frequency and severity was not anticipated.

In the present study, there were more instances of work-related pain than of injury reported, and therefore more variability in measures of pain than in measures of injury. This could explain the differences observed in the strength of the relationships between workplace sleepiness and injury versus pain. One factor that likely contributed to the limited variability in injury frequency was the response options provided for injury items. Participants were asked whether they had experienced each of 15 different injuries. Then the number of injuries was summed to produce an injury frequency score. Participants could not report any more than one instance of each type of injury. It is quite possible that participants experienced multiple instances of some of these injuries. Therefore, this procedure likely artificially restricted the range of injury frequency.

This measurement method also was used with pain frequency. Although this method also likely limited its variability, there were so many participants in this study experiencing each type of pain the response format did not seem to pose a problem. There is a large discrepancy between the frequency with which each type of injury was reported and the frequency with which each type of pain was reported. Specifically, 11 or fewer people reported having experienced 12 of the 15 injuries; and more than 11 people reported every single type of pain. In fact, 60 or more respondents reported each of the following types of pain: neck, shoulder, lower back, and foot. In future research, it would likely be beneficial to ask participants to report the number of instances of each type of injury and pain and then calculate sums for injury frequency and pain frequency.

The measurement technique used to assess injury severity also may contribute to the inability to detect a significant relationship with workplace sleepiness. Injury severity was indexed as the amount of time taken off work due to injury. Anecdotal evidence suggests that there was likely a lack of variability in this measure because CNAs tend to avoid taking time off work for financial reasons. When talking to CNAs informally during data collection, it became clear that many live paycheck to paycheck, and that they are not paid a great deal (median hourly rate of \$10.07) (USBLS, 2006). This calls into question the practice of indexing injury severity among CNAs as the amount of time taken off work. This practice is discussed further in Section 4.3.

#### 4.2. Safety behavior as a mediator

The results of this study provide limited support for the hypothesis that safety behavior functions as a mediator. The mediation hypothesis was upheld only in the case of pain frequency. The mediation hypothesis might not have been upheld for injury frequency and injury severity due to limitations in variability. The mediation was also not upheld for pain severity-duration or pain severity-intensity. It is within the realm of possibility that safety behavior might mediate the relationship between workplace sleepiness and pain frequency and not the relationship between workplace sleepiness and pain severity. A person might be sleepier at work, and as a result his/her safety behavior might decrease, and that might make him/her more likely to experience some work-related pain. However, the decrements in safety behavior might not necessarily lead to more severe pain. A person might be sleepy, and as a result not pay attention to a slippery floor sign. This person then might be more likely to slip and fall and have pain as a consequence. However, environmental factors such as how slippery the floor was, the position of the person's body in space, and the presence or absence of other objects in the person's path might have a greater bearing on

the severity of the resulting pain than the sleepiness related safety behavior decrements.

The mediation hypothesis was upheld for pain frequency; yet, it should be noted that the results do not support full mediation, but do support partial mediation. Full mediation means that workplace sleepiness is related to pain frequency only indirectly through safety behavior. Partial mediation means that workplace sleepiness is related to pain frequency not only indirectly through safety behavior, but also directly (Baron and Kenny, 1986). As noted previously those who are sleepy in the workplace could have greater pain sensitivity (Kundermann et al., 2008; Lautenbacher et al., 2006; Nascimento et al., 2007; Smith et al., 2005). Despite there being empirical support for this notion, there has been little field research on the topic in nonclinical populations.

This result specifically and the mediation results in general suggest that the relationship between workplace sleepiness and occupational injuries might not be simple. Little research has explored potential mediators of workplace sleepiness–occupational injuries relationship. Yet, the assumption has been made that the two constructs are linked by decrements in job behavior (Chau et al., 2002; Melamed and Oksenberg, 2002). The current study suggests that we may not understand this relationship as well as we may have assumed. This is problematic. If we do not understand this relationship, we will not be able to identify the circumstances which should cause an organization to be concerned about workplace sleepiness. Further if workplace sleepiness is a concern, it will be difficult to develop effective interventions to improve occupational safety outcomes (e.g., reduce work-related pain).

#### 4.3. Limitations

Although this research makes important contributions to the workplace sleepiness research literature and offers a number of suggestions for future research, it is not without limitations. First, this study involved solely self-report data collected at one point in time. This raises a concern that the observed relationships could have been inflated due to common method variance or monomethod bias. Common method variance or monomethod bias refers to variance shared by variables due to the common method which was used to collect data. It is likely socially desirable to report low levels of workplace sleepiness, a high level of safety behavior, and few occupational injuries. With this being the case, future research should use other sources of data (e.g., official injury records, supervisory ratings of safety performance, etc.) to reduce these concerns. However, it should be noted that the results of this study suggest that the effect of common method variance may have been very minimal. The relationships between safety behavior and injury frequency/severity and pain severity were weak. Further, the means for the sleepiness (i.e., 2.504) and pain measures (e.g., 3.161) were not terribly low nor the mean for the safety performance (i.e., 42.427) measure terribly high (see Table 1). One might anticipate different results if social desirability was driving participant survey responses.

Second, a cross-sectional design does not allow one to rule out the possibility that a causal chain could work in the reverse. The mediation hypothesis that was upheld could indicate that increases in workplace sleepiness lead to decrements in safety behavior which lead to increases in work-related pain. However, these results also could indicate that more pain could lead to decrements in safety behavior, and as a result to increased workplace sleepiness. One possible explanation for the partial mediation result noted previously is that pain might impact workplace sleepiness. Some suggest that pain disturbs sleep (Shaver, 2008; Takahashi et al., 2006), and sleep problems can lead to workplace sleepiness. We

acknowledge that this study is only the first step in exploring safety behavior as a mediator of the workplace sleepiness–occupational injury relationship. The next step should include a study using an experimental design in which the independent variable is manipulated.

Finally, injury severity was indexed as the amount of time taken off work due to injury. Anecdotal evidence suggests that CNAs may not take time off of work due to injury for financial reasons. As a result, this type of measure may be less than ideal for this population. However, a review of occupational injury research shows that other methods might not be able to address this issue, either. For instance, another method for assessing injury severity involves asking whether the injury required medical attention. CNAs might not seek medical attention for an injury because they often do not have medical insurance or have poor medical insurance (Case et al., 2002; Potter et al., 2006). Granted, a visit to the doctor would be covered if a CNA chose to file a workers' compensation claim. However, research suggests that healthcare workers might hesitate to report an injury to a supervisor or facility administrator, let alone file a workers' compensation claim (Agnew, 1987; Blegen et al., 2004; Brown et al., 2005; Owen, 1989; Porta et al., 1999). Future research needs to explore how injury severity might be measured more effectively in this population and other similar populations.

#### 4.4. Conclusions

A great deal of research has investigated the relationships between sleepiness-related variables and occupational injuries. Implicit in most of this research is the assumption that these variables such as sleep quality and sleep quantity are related to occupational injuries due to workplace sleepiness-related behavior decrements. In other words, it has been assumed that job behavior is the glue that connects these sleepiness-related variables with occupational injuries. The current research tests this assumption, and in so doing, helps to address a significant gap in the existing occupational safety research literature.

Unlike prior research in this area the current study focused specifically on workplace sleepiness rather than general sleepiness and variables that are likely related to sleepiness. This is an important contribution to the literature given that workplace sleepiness and these other variables are likely different (i.e., one could be sleepy at home where he/she has fairly little to do yet alert at work because his/her work is dynamic and stimulating). This study also took a very comprehensive view of occupational injuries measuring injury severity, pain frequency, and pain severity (duration and intensity) in addition to injury frequency. Our findings were not entirely consistent with long-held assumptions. There was only evidence to suggest that safety behavior might mediate the relationship between workplace sleepiness and pain frequency. This suggests that the relationship between workplace sleepiness and occupational injuries may be more complex than assumed.

Results of the National Sleep Foundation's annual poll show that 26% of a sample of working adults experience daytime sleepiness that interferes with their daily activities at least a few days a week (NSF, 2008). With the current economic situation there are more and more demands being put on working adults that could impact their sleep and subsequent workplace sleepiness. It is hoped that these statistics in conjunction with the findings of the current study are a call to action for occupational safety researchers. There is a need to better understand the relationship between workplace sleepiness and occupational injuries, and there should be replications and extensions of this study. The findings of the current study point to a number of ways in which future research in this area can be enhanced.

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