THESIS

THE ROLE OF OCCUPATIONAL STRESSORS IN SLEEPINESS: A QUANTITATIVE REVIEW

Submitted by

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WE HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER OUR SUPERVISION BY SARAH DEARMOND ENTITLED THE ROLE OF OCCUPATIONAL STRESSORS IN SLEEPINESS: A QUANTITATIVE REVIEW BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE.

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ABSTRACT OF THESIS

THE ROLE OF OCCUPATIONAL STRESSORS IN SLEEPINESS: A QUANTITATIVE REVIEW

Krauss, Chen, DeArmond and Moorcroft (2003) called attention to the lack of research on workplace sleepiness. These authors also proposed a number of antecedents of workplace sleepiness, which included occupational stressors. The current study investigated the relationship between seven occupational stressors and workplace sleepiness/sleepiness surrogates via a meta-analytic approach. The results of the analyses showed that six of the occupational stressors (role ambiguity, role conflict, workload, interpersonal conflict, situational constraints, perceived control) had small to moderate relationships with workplace sleepiness/sleepiness surrogates (the relationship between traumatic/acute stressors and workplace sleepiness/sleepiness surrogates was not analyzed due to an insufficient number of relevant data points). Although moderators were suggested for the relationships between role ambiguity, workload, perceived control, and workplace sleepiness/sleepiness surrogates, only one potential moderator (type of workplace sleepiness/sleepiness surrogate scale) was investigated for the

relationship between workload and workplace sleepiness/sleepiness surrogate because of practical constraints. The type of workplace sleepiness scale was not found to moderate the relationship. The meta-analyses suggest that this is an important area for future research.

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CHAPTER I

INTRODUCTION

The 2002 National Sleep Foundation poll revealed that 90% of respondents felt that a lack of sleep influenced their performance and their safety at work. This finding calls attention to an important topic of research, sleepiness in the workplace. A recent review of this area by Krauss, Chen, DeArmond, and Moorcroft (2003) also pointed out the apparent lack of systematic research and definitive findings in occupational health in general, and workplace sleepiness in particular. As suggested by the model proposed by Krauss et al. (2003) occupational stressors are considered possible antecedents of workplace sleepiness. While there has not been an over abundance of research publications focused on the effect of stressors on sleepiness in the workplace, many studies have addressed the linkages between occupational stressors and somatic symptoms (Spector & Jex, 1998) as well as decrements in sleep quantity and quality (Martens, Nijhuis, Van Boxtel, & Knottnerus, 1999). The focus of the current research is to examine the role of occupational stressors in sleepiness using a meta-analytic approach. In the paragraphs that follow the general concepts of stress and sleep will be defined and reviewed. Further, more specific concepts such as workplace sleepiness and occupational stressors will be considered. Based on past research, hypotheses will be set forth for the meta-analysis and then methods will be described.

Sleep

There are two types of sleepiness: physiological and subjective. Physiological sleepiness is the consequence of too little sleep or disruptions to the internal biological clock (Carskadon & Dement, 2000). Subjective sleepiness is the result of a variety of things: work environment, job or task characteristics, stressors and strains, motivation, diet, and finally actual physiological sleepiness (Carskadon & Dement, 2000).

To better understand sleepiness the concept of sleep must first be reviewed. Sleep is controlled by the brain (Culebras, 2002). The brain assesses whether the body needs sleep by evaluating two important factors: sleep quota and the internal 24-hour biological clock/circadian rhythm. Sleep quota or the amount of sleep one needs is determined by the amount of previous sleep and the amount of time awake. Sleep quota increases by roughly one hour for every two hours spent awake (Krauss et al., 2003) and decreases by each hour spent asleep. The internal 24-hour biological clock is like an alarm clock. Instead of indicating just what time to get up, this alarm clock indicates also when it is time to go to bed. Most internal 24-hour biological clocks are at least similar in that they generally indicate that the hours between 10pm and 6am are for sleeping (Culebras, 2002). Further, this clock usually also indicates a period of secondary sleepiness from 2pm to 4pm. While the alarm may go off during this two-hour block in the afternoon, it is generally easier to turn off than the alarm that goes off at night. In essence this period may be felt as intense drowsiness. The times listed here are generally

the same for most individuals; however, some people's clock may be shifted an hour earlier or later.

Two different phases of sleep have been identified. The two phases are non-rapid eye movement sleep (NREM sleep—this phase is sometimes referred to as Slow Wave Sleep) and rapid eye movement sleep (REM sleep). Generally NREM sleep is described as "synchronous" and this is the phase through which one enters sleep (Carskadon & Dement, 2000). The early stages of sleep may begin without individuals being aware that they are beginning to sleep. That is why researchers often use a variety of apparatus, such as the electroencephalogram (EEG) assessing brain activities, electrooculogram (EOG) recording eye movement, and electromyogram (EMG) measuring muscle movements, to help them to identify the beginning and subsequent stages of sleep.

There are specific waves on each of these three devices that indicate that an individual is awake, asleep, and the different stages of sleep that he/she might be experiencing. While being awake, alpha (slower, regular, moderate voltage) and beta (fast, irregular, low voltage) waves predominate the EEG, constant eye movements, and a thick band of vertical lines on the EMG (this indicates a lot of muscle movement). When one begins to fall asleep the EEG shows theta waves (these waves are even lower voltage than alpha waves), slow eye movements (looks like a slow rolling pattern on the EOG), and less muscle activity (marked by a thinner line on the EMG).

REM sleep usually occurs 80 minutes or longer after entering sleep through NREM. During REM sleep one's body is paralyzed but his or her brain is active. This is

the phase of sleep in which dreaming takes place. NREM and REM sleep alternate throughout the night. There are four stages within NREM sleep. Stage 1 sleep generally lasts 1-7 minutes and can be easily stopped (Carskadon & Dement, 2000). Stage 2 sleep is characterized by sleep spindles or K complexes on the EEG and lasts for 10-25 minutes. Stage 3 is signaled by high-voltage slow EEG waves, referred to as delta waves. During this stage delta wave (slow wave) activity must account for more than 20% and less than 50% of EEG activity. Stage 3 doesn't last very long and transits to Stage 4 sleep with an increase in high-voltage slow wave activity (increases in the amount of delta waves). In the first cycle of sleep, Stage 4 generally lasts for about 20-40 minutes. However, Stage 3 and 4 sleep becomes shorter and sometimes disappears altogether throughout the night. The first NREM-REM cycle usually lasts 70-100 minutes. Over the night the NREM-REM cycle averages 90-110 minutes (Carksadon & Dement, 2000), and REM sleep episodes become longer as the night goes on. The propensity for REM sleep is circadian. REM sleep is more likely and will generally last longer in the early morning hours (4am-7am) (Moorcroft, 1993).

When a person does not get enough sleep, that person tends to feel sleepy (Webb & Cartwright, 1978). When physiological sleepiness intrudes on one's daily activities, loss of energy, fatigue, weariness, difficulty concentrating, performance decrements, and memory lapses may be experienced. It is thought that some performance decrements are the result of what is called microsleeps. Microsleeps are 1 to 10 second periods in which

a person slips into Stage 1 sleep while still appearing to be awake (Roehrs, Carskadon, Dement, & Roth, 2000).

It is clear that decrements in sleep can cause people to feel sleepy and that this sleepiness may have severe consequences. Therefore measuring sleepiness has become important. While researchers can measure sleepiness physiologically by using the EEG, the EOG, and the EMG as noted in previous paragraphs, the cost involved with using these devices is not always practical. Therefore there have been a number of indices created to measure subjective daytime sleepiness. These include the Sleep-Wake Activity Inventory (SWAI, Rosenthal, Roehrs, & Roth, 1993), the Stanford Sleepiness Scale (SSS, Hoddes, Zarcone, & Dement, 1972), and the Epworth Sleepiness Scale (ESS, Johns, 1991). The Stanford Sleepiness Scale is perhaps the best validated of the three measures. Two other subjective sleepiness scales include the Karolinska Sleepiness Scale (KSS, Arkerstedt & Gillberg 1990) and the Visual Analogue Scale (VAS, Freyd, 1923). These scales ask respondents to rate his/her current state based on a scale of alertness.

Other alternate physiological measures include the Multiple Sleep Latency Test (MSLT) and the Maintenance of Wakefulness Test (MWT). The MSLT is a well-validated measure in both clinical and experimental populations. It measures the latency to fall asleep at 2- hour intervals repeatedly throughout the day. Subjects have to lie in a dark bed and try to stay awake. Similar to the MSLT, the MWT also requires subjects to lie in bed or sit in a chair in a dark room and try to stay awake.

Krauss et al. (2003) noted that the, "general foci of sleep research have been that of sleep disorders, general sleep patterns in various developmental stages, the effects of work schedule on sleep (Garbarino, Beelke, Costa, Violani, Lucidi, Ferrillo, & Sannita, 2002), and the relationship between type of occupation and sleep (e.g., physician, Lewis, Blagrove, & Ebden, 2002; professional driver, Horne & Reyner, 1995)." However, little research has specifically examined the relationship between occupational stressors and sleepiness in general (or workplace sleepiness in particular). Thus, the focus of the current study was on the relationships of occupational stressors with sleepiness as well as various sleepiness surrogates, which include sleep quality, sleep quantity, fatigue, and sleepiness-related somatic symptoms.

Sleep quality was chosen as a surrogate due to evidence that indicates a relationship between this variable and sleepiness (Pilcher, Schoeling, & Prosansky, 2000, Pilcher, Ginter, & Sadowsky, 1997, Gundel, Drescher, Maass, Samel, & Vejvoda, 1995). The most notable of the evidence, was a recent study by Pilcher et al. (2000). In this study sleep quality proved to be a significant predictor of sleepiness. There has also been evidence to support the notion that decreases in sleep quantity lead to sleepiness (Rogers, Caruso, & Aldrich, 1993). Further it is noted by sleep researchers that for the average person it takes roughly one hour of sleep to compensate for two hours of wakefulness. Laboratory experiments have shown that when sleep quotas are not met the brain can quickly shift to a state of sleep. Therefore it seems logical to expect that individuals would show increases in sleepiness when they have decreases in sleep quantity.

In addition to sleep quality and quantity, fatigue and sleepiness-related psychosomatic symptoms were also viewed as surrogates due to the inclusion of items on fatigue and psychosomatic symptom inventories that address sleepiness: "I get tired very quickly" (Michielsen, DeVries, & Van Heck, 2003), "mentally I feel exhausted" (Michielsen et al., 2003), "physically I feel exhausted" (Michielsen et al., 2003), "Have you had trouble sleeping?" (Spector & Jex, 1998), "Have you felt tired or fatigued?" (Spector & Jex, 1998). In summary, for the purposes of the current research, literature addressing sleep quality, sleep quantity, psychosomatic symptoms, and fatigue was included in the meta-analysis. Great care was taken in the analyses to consider differences between indices of actual sleepiness and the various sleepiness surrogates.

It should be noted that there are a number of other types of measures that include sleepiness related items. Examples are depression and anxiety measures. Despite the inclusion of sleepiness-related items, these measures were not considered as sleepiness surrogates for the following reason. Generally these types of measures ask respondents to rate each statement based on a long period of time frame such as "in general," "past year", "past months", etc. These time frames tend to be longer than those of psychosomatic symptom inventories or fatigue measures. Hence, neither sleep-related items in depression nor anxiety measures were considered as surrogates in the current study.

Stress

Stress is a topic that has received a considerable amount of attention in the occupational health realm in the past decades. One topic surrounding stress that has been controversial is the definition of stress. There are a variety of opinions. Some consider stress to be a stimulus. These theorists consider stress to be environmental stimuli that require individuals to make adaptive responses. Some of the first researchers to conceptualize stress in this way included Kahn, Wolfe, Quinn, and Snoek (1964). Others consider stress to be a response. These theorists are conceptualizing stress as the feelings that one has as a result of demands made upon this person. Selye, a stress research pioneer referred to stress as "the nonspecific result of any demand upon the body" (Selye,1936). Selye (1975) further described the response to demands as the general adaptation syndrome (GAS). He conceptualized stress as the biochemically altered state one entered as a result of what he called a stressor (environmental stimuli). Finally some theorists think of stress as having a wider scope and being the entire stimulus-response process. These same theorists in turn term the stimuli to be stressors and the negative responses to be strain, and refer to stress as an area of study (McGrath, 1976). Other researchers that have taken this viewpoint include Beehr and Franz (1986) and Schuler (1980). This perspective was adopted in the current study. Among the variety of occupational stressors proposed in the literature, only broad (stressors that might exist in most jobs) frequently studied occupational stressors, including role ambiguity, role

conflict, workload, interpersonal conflict, situational constraints, perceived control, and traumatic/acute stressors were included. Stressors that involve anything external to one's job (e.g., work-family conflict) or that were very specific to certain types of jobs (e.g., shiftwork) were excluded. Reviews of the stressors that were included follow.

Role Ambiguity. Role ambiguity refers to "the degree to which required information is available to a given organizational position" (Kahn et al., 1964, p. 25). Role ambiguity is dependent upon how clearly and consistently information regarding an employee's role requirements and position within an organization is communicated to that employee. Two frequently used measures of role ambiguity are scales by Rizzo, House, and Lirtzman (1970) and Beehr, Walsh, and Taber (1976). An example of an item that is included on these role ambiguity scales is "Clear, planned goals and objectives exist for my job" (Rizzo et al., 1970). There is a vast array of examples of role ambiguity. In a very general sense role ambiguity could occur as a result of a simple miscommunication between a supervisor and a subordinate about what is expected of the latter. More specifically tasks of some jobs are hard to define. One such job would be computer programming. Computer programmers are responsible for coming up with and developing software that is new and unique. Therefore, there are not clear and well defined behaviors that they must engage in. In fact in the case of a computer programmer clarity might inhibit the creative process. Another thing that might result in role ambiguity is change. For instance, with the advent of computers, the job of librarian changed dramatically. With this change, suddenly a librarian's required knowledge and

skills were not only different in some cases but also unknown. Finally, many jobs may be poorly defined. Quite often job descriptions become outdated, given the nature of work has drastically changed. Therefore job descriptions given to new recruits might be misleading, which in turn results in role ambiguity.

Kahn et al. (1964) suggest that the confusion and uncertainty induced when information is communicated unclearly and/or inconsistently is associated with strain such as tension and anxiety. Since 1964, there have been numerous studies connecting role ambiguity with different indices of strain, employee well-being, and organizational outcomes. Role ambiguity has been linked to negative affect and somatic symptoms (Gavin & Axelrod, 1977; Spector & O'Connell, 1994; Van Dijkhuizen & Reiche, 1980). Jackson and Schuler (1985) did a meta-analysis in which they found average corrected correlations of role ambiguity with job satisfaction (-.46), tension/anxiety (.47), organizational commitment (-.41), absence (.13), propensity to leave (.29), and self-ratings of job performance (-.12). Most notable for the current research are the connections that have been made in research literature between role ambiguity and somatic symptoms (Spector & O'Connell, 1994, Spector, Dwyer,& Jex, 1988, Kemery, Mossholder, Bedeian, 1987, Frone, Russell, & Cooper, 1995). For instance Spector et al. found a significant relationship between role ambiguity and somatic symptoms which lead to consultation with a doctor. As a result of these findings the following was hypothesized:

Hypothesis 1: Role ambiguity will be positively correlated to sleepiness and sleepiness surrogates.

Role Conflict. Kahn et al. (1964, p. 19) defined role conflict as "the simultaneous occurrence of two (or more) sets of pressures such that compliance with one would make more difficult compliance with the other". Rizzo et al. (1970) not only constructed a role ambiguity scale, but also a role conflict scale. An example of an item that is included on this role conflict scale is "I receive incompatible requests from two or more people" (Rizzo et al., 1970). Role conflict can be exhibited in one of three forms: intra-sender conflict, inter-sender conflict, and inter-role conflict. Intra-sender conflict occurs when an employee is given conflicting instructions by one particular person. This person is considered a role sender who gives role-relevant information (Kahn et al., 1964). An example would be if an employee is told by a supervisor to complete a particular task by the end of the day, but is also told by the same supervisor to do the task alone. The conflict would occur, if this person could complete the task alone but not by the end of the day. So in essence the supervisor is asking the employee to complete the task on a timeline that calls for teamwork, but is asking that the employee not elicit the help of others. The second form of role conflict is inter-sender conflict. This type of conflict occurs when two role senders are putting pressure on someone to do two things that are in conflict of one another. For instance, one supervisor might ask a subordinate to complete a task by the end of the day and another supervisor could ask the subordinate to do the

task alone. Here conflict emerges when requests of both supervisors cannot be met. The last form of role conflict, inter-role conflict, refers to a situation in which pressures from one role conflict with pressures from another (Kahn et al., 1964). This type of conflict occurs when someone holds more than one role within an organization. For instance, an employee might have a formal role as a machinist and also serve as the union representative for machinists in his/her plant. This employee could face increasing pressure from the union to carry out specific duties, yet, those duties could come in direct conflict with required parts of this person's formal job.

The common vein running through all of the above types of role conflict is pressure to do things differently. It is suggested that this pressure to change upsets an existing equilibrium that leads to strain (Kahn et al., 1964). Role conflict has proven to be related to a vast variety of both individual well-being and organizational consequence variables. Based on meta-analytic results, Jackson and Schuler (1985) reported corrected average correlations between role conflict and the following consequences: job satisfaction (-.48), tension/anxiety (.43), organizational commitment (-.36), propensity to leave (.34), and job performance (as rated by others, -.11). Like role ambiguity, the evidence which connects this stressor and sleepiness revolves around somatic symptoms. It has been a consistent finding that role conflict is positively correlated with somatic symptoms (Kemery, Mossholder, & Bedeian, 1987, Spector et al., 1988, Spector & O'Connel, 1994, Fusilier, Ganster, & Mayes, 1987, Ganster & Schaubroeck, 1991). As a result the following hypothesis was proposed.

Hypothesis 2: Role conflict will be positively correlated to sleepiness and sleepiness surrogates.

Workload. Workload refers to the amount and complexity of the work that employees have to do. Researchers have conceptualized workload in a variety of ways such as number of projects completed, number of work hours, or speed of production rate. One concept similar to workload is role overload. Role overload deals specifically with an excess of role specific demands. Workload deals with demands that are not necessarily specific to one's role(s). Role overload deals with excessive amounts or complexity of role specific work, while workload deals with a range of work quantities and complexities (Jex, 1998). Given their similarity on overload, role overload will be considered a type of workload from this point forward. A frequently used scale measuring workload is the Quantitative Workload Inventory (QWI) constructed by Spector and Jex (1998). This inventory includes items such as, "How often does your job require you to work very hard?"

The consequences of workload have received a great deal of attention in the literature. There have been studies finding significant relationships between everything from general well-being (Van den Berg & Schalk, 1997) to coronary heart disease (Haynes, Feinleib, & Kannel, 1980; McCann, Benjamin, Wilkinson, Retzlaff, Russo, & Knopp, 1999). Research has shown workload to be correlated with psychological symptoms including tension, nervousness, irritability, unusual tiredness, and difficulties concentrating (Kirmeyer & Dougherty,1988; Kivimaeki, & Lindstrom, 1995). Further

workload has been correlated significantly with physical health complaints such as headaches, stiffness in neck and shoulders, and burning eyes (Carayon, 1993; Repetti, 1993). Spector et al. (1988) did a study in which they attempted to take more objective measures of occupational stressors by having supervisors report on the matter. They found a significant positive correlation between the number of hours worked reported by the supervisor and the number of health symptoms reported by the workers.

Other research also provide evidence that workload has a negative effect on sleep quality (Martens et al., 1999), physical and psychological health (Kirkcaldy, Levine, & Shephard, 2000; McCann et al., 1999; Schulz, Kirschbaum, Pruesner, & Hellhammer, 1998). McCann et al., for instance, found that increases in workload were associated with increases in concentrations of triglycerides in the bloodstream. Elevated levels of triglycerides have been linked to cardiovascular disease. Schulz et al. (1998) also revealed that those experiencing chronically high levels of workload tend to experience high cortisol secretions upon awakening in the morning. The authors note that increases in cortisol increases arousal levels and suggest that a possible consequence of enhanced morning arousal might be early exhaustion later in the day. Kageyama, Nishikido, Kobayashi, and Kawagoe (2001) found a significant relationship between weekday sleep dept (the difference between one's required sleep length and their actual sleep length on weekdays) and workload. As a result of these findings hypothesis three was set forth.

> Hypothesis 3: Workload will be positively correlated to sleepiness and sleepiness surrogates.

Interpersonal Conflict. Interpersonal conflict involves anything from minor disagreements to physical fights that take place at work. Interpersonal conflict might be the result of differences in people, perceptions of unfair treatment, or competitive environments. Often researchers focus on overt forms of interpersonal conflict (i.e. physical fights, overt verbal attacks). However, covert forms (i.e. spreading rumors, talking about coworkers behind their backs, and sabotage) should not and will not be overlooked in the current research. Two frequently used measures of interpersonal conflict are the Interpersonal Conflict at Work Scale (ICAWS, Spector & Jex, 1998) and the Workplace Incivility Scale (Cortina, Magley, Williams, & Langhout, 2001). An example from the Workplace Incivility Scale is "During the past five years have you been in a situation where any of your superiors or coworkers put you down or was condescending to you?" (Cortina et al., 2001).

Over the years research has shown interpersonal conflict as being related to increases in negative mood (Fox, Spector, & Miles, 2001, Repetti, 1993), counter productive work behaviors (Fox et al., 2001), job dissatisfaction (Sutton, 1984, Spector et al., 1988), burnout (Brondolo, Masheb, Stores, Stockhammer, Tunick, Melhado, Karlin, Schwartz, Harburg, & Contrada, 1998), and intention to quit (Spector et al., 1988). More notably for the current research purposes, interpersonal conflict has been shown to be correlated with psychological symptoms including nervousness, irritability, unusual tiredness, and difficulties concentrating (Kivimaeki, & Lindstrom, 1995) and physical

symptoms including trouble sleeping and tiredness and fatigue (Spector & Jex, 1998, & Spector et al., 1988). Spector et al. measured interpersonal conflict of a worker from both sources: self and the worker's supervisor. These authors found significant positive correlations between interpersonal conflict and anxiety and frustration. As noted previously anxiety is significantly related to poorer quality of sleep (Ware, 1988; Fuller, Waters, Binks, & Anderson, 1997; McCann & Stewin, 1988; Gray & Watson, 2002; Kumar & Vaidya, 1982). Finally and perhaps most notably for the current purposes Bergmann and Volkema (1994) found that "lost sleep" was the second most common consequence of an interpersonal work conflict. As a result of this research the following hypothesis was made:

> Hypothesis 4: Interpersonal conflict will be positively correlated to sleepiness and sleepiness surrogates.

Situational Constraints. Situational constraints refer to organizational conditions that hinder job performance. For instance when one has a task that requires a financial resources for successful completion and those resources are lacking, frustration as well as negative experiences may result (Peters & O'Conner, 1980). Two common measures of situational constraints are the Organizational Constraints Measure (Mathieu, Tannenbaum, & Salas, 1992) and the Organizational Constraint Scale (Spector & Jex, 1998). Scales such as these contain items such as, "How often do you find it difficult or impossible to do your job because of poor equipment?" (Spector & Jex, 1998). Through the years situational constraints have proven to be related to counterproductive work

behaviors (Fox et al., 2001), negative emotion (Fox et al., 2001), frustration (Jex & Gudanowski, 1992, Spector et al., 1988, O'Conner, Pooyan, Weekley, Peters, Frank, & Erenkrantz, 1984, Peters, O'Connor, Eulberg, & Watson, 1988), anxiety (Jex & Gudanowski, 1992; Spector et al., 1988), intent to quit (Jex & Gudanowski, 1992; Spector et al., 1988), turnover (O'Conner et al., 1984; Peters et al., 1988), and job dissatisfaction (Jex & Gudanowski, 1992, O'Conner et al., 1984, Peters et al., 1988, & Spector et al., 1988). Again the existing evidence linking situational constraints most closely to sleepiness include significant positive correlations between this variable and somatic symptom inventories (that include sleepiness related items). Spector et al. (1988) and Spector and O'Connell (1994) have both found positive correlations between these two variables. More notably, in a meta-analysis, Spector and Jex (1998) reported a positive mean correlation between situational constraints and somatic symptoms. As a result of this research the following was hypothesized:

> Hypothesis 5: Situational constraints will be positively related to sleepiness and sleepiness surrogates.

Perceived Control. Perceived control (also referred to as decision latitude by Karasek, 1979) refers to how much discretion an employee has in how he/she goes about completing tasks and the role one is allowed in making decisions. Two common measures of perceived control include the Global Work Autonomy Scale (Breaugh, 1985) and the Control Scale (Dwyer & Ganster, 1991). An example of an item from these scales is "How much control do you have over the variety of methods you use in

completing your work?" (Dwyer & Ganster, 1991). Perceived control has been reported to be negatively associated with negative emotion (Fox et al., 2001) and counterproductive work behavior (Fox et al., 2001), and job related depression (Haynes, Wall, Bolden, Stride, & Rick, 1999). Perceived control has also been shown to have a significant positive correlation with job satisfaction (Haynes et al., 1999). Carayon (1992) found perceived control to significantly predict a decrease of boredom, tension/anxiety, depression, and anger. Further, empirical findings have shown negative correlation of perceived control with physical health complaints (Carayon, 1993) and psychological symptoms (Kivimaeki & Lindstrom, 1995). Spector's (1986) meta-analytic results also revealed that high levels of perceived control were associated with low levels of physical symptoms such as sleep decrements. As a result the following hypothesis was made:

> Hypothesis 6: Perceived control will be negatively correlated to sleepiness and sleepiness surrogates.

Traumatic/Acute Stressors. Traumatic or acute stressors are the last major category of stressors to be considered here. Most of the previously mentioned stressors have been chronic in the sense that they are environmental conditions that are consistently present (Pratt & Barling, 1988). Traumatic/acute stressors are generally thought of as rare occurrences with intensive impact at a particular moment (Pratt & Barling, 1988). This category might include: a shooting between police and criminals (Loo, 1986), damage to one's business due to a hurricane (Sanchez, Korbin, & Viscarra,

1995), or layoffs (Feldman, Leana, & Bolino, 2002). Generally, traumatic/acute stressors are not measured by scale or inventories such as chronic stressors. Such as in the Sanchez et al. (1995) study a hurricane occurred and individuals experiencing damage to their businesses, were surveyed with regard to their reactions. Traumatic/acute stressors have proven to be related to increased blood pressure (Lepore, Allen, & Evans, 1993; Uchino & Garvey, 1997; Lepore, 1995; Eden, 1990), heart rate (Uchino & Garvey, 1997; Eden, 1990) cholesterol (Stoney & Finney, 2000), and triglyceride levels (Stoney & Finney, 2000). Notable for the current research, Eden (1990) found exposure to an acute stressor to be associated with increases in psychosomatic complaints (the complaint inventory used included an item involving tiredness in the absence of effort). A number of studies have shown that one consequence of experiencing traumatic/acute stressors is sleep pattern disturbances (Farnill & Robertson, 1990; Burke, 1994; Loewenthal, Eysenck, Harris, Lubitsh, Gorton, & Bicknell, 2000; Neylan, Metzler, Best, Weiss, Fagan, Liberman, Rogers, Vedantham, Brunet, Lipsey, & Marmar, 2002). These disturbances could result in sleepiness at work. As a result the following hypothesis was set forth:

> Hypothesis 7: Traumatic stressors will be positively correlated to workplace sleepiness and sleepiness surrogates.

CHAPTER II

METHOD

The current study utilized a meta-analytic approach to examine the relationships between occupational stressors and sleepiness/sleepiness surrogates. Meta-analysis is a means of combining the findings of a variety of studies quantitatively, and attempts to estimate the population correlations. While meta-analysis has become a popular and a relatively well-respected technique in the field of psychology, it has not gone without criticism. Two common criticisms that may have particular significance for this study is what Rosenthal and DiMatteo (2001) referred to as "garbage in and garbage out" and "combining apples and oranges".

In a meta-analysis one is combining studies that vary on a lot of dimensions and one of those dimensions is quality. The argument is that in meta-analysis one may include studies that are methodologically unsound and that may affect the quality of the results negatively (Rosenthal & DiMatteo, 2001; Wanous, Sullivan & Malinak, 1989). While some researchers advocate weighting studies based on their methodological strength (Rosenthal, 1991), others advocate careful review and selection of studies used in the meta-analysis. The latter is the strategy that was used in this study.

The second criticism, combining apples and oranges, also revolves around concerns of combining studies that are very different. In this case the concern is on

variability in how studies operationalize constructs of interest and sample the population. Specifically researchers with these concerns argue that an overall correlation coefficient obtained in a meta-analysis combining studies that vary widely in their operationalizations of key variables would be theoretically meaningless (Lipsey & Wilson, 2001). Given that there is little research investigating the relationship between occupational stressors and workplace sleepiness, different sleepiness surrogates (i.e., proxies for actual sleepiness measures) such as fatigue, sleep quality, sleep quantity, and sleep related psychosomatic symptoms were used in the current study. However, these surrogates are arguably conceptually similar. One thing that should be noted is that some argue in favor of including studies with some variation in operationalizations. Rosenthal and DiMatteo (2001) argue that variability of studies actually may help to increase the generalizability of meta-analysis findings. Further they argue that steps can be taken to account for differences. This can be done by exploring moderator variables. In the current study, three possible moderators were studied which included measures of a particular job stressors (e.g., different measures assessing workload or role ambiguity), type of sleepiness measure (i.e., actual sleepiness, sleepiness-related psychosomatic symptoms, fatigue, etc.) and type of sample (i.e. military or non-military).

Literature Search and Inclusion Criteria

An extensive literature review was conducted. Psychinfo (1960-June 2003, Medline (1966-June 2003), and the Social Science Citation Index (1960- June 2003) were searched. The searches began with 1960 because it was during this decade that

occupational stress research began to be published, and data from studies published then might still be available. A variety of searches were conducted using terms including stress, sleep, psychosomatic symptoms, somatic symptoms, and individual stressor names (role conflict, role overload, workload, interpersonal conflict, etc.). Two criteria were used to include articles for the current study. First, articles that provided correlation coefficients (or data that could be converted to a correlation) for relationships between the occupational stressors of interest and sleepiness or one of the sleepiness surrogates including sleep quantity, sleep quality, fatigue, or sleepiness related psychosomatic symptoms were retained. If sleep variables were part of psychosomatic symptom inventories, the correspondent correlations were requested from authors of these articles. Second, studies were only included if samples of employees were used. A total of 498 studies were reviewed and only 26 studies were retained for the meta-analysis. This small number may be attributed to several things. One was that upon closer review many of the studies did not have all the information needed. Another was that many of the necessary correlations could not be obtained. This was the result of being unable to locate authors, authors not responding to correspondence, not having time to rerun analyses, or no longer having access to the data (See Figure 1).

Meta-Analysis Procedures

The current meta-analysis was conducted based on the procedures outlined by Hunter and Schmidt (1990). First, sample-size weighted mean correlations were calculated for each of the stressors with sleepiness. Weighted sample correlations are the

average of the sample-size-weighted correlations. In conjunction with the sample-size weighted mean correlations, sample-size weighted variance (s_r^2) was also calculated. Sample-size weighted variance is an estimate of the variation in different correlations after weighting for sample size. Next, both 95% homogeneous and heterogeneous confidence intervals were constructed around the sample size-weighted mean correlations. Confidence intervals were used to assess the accuracy of the correlation estimates (Whitener, 1990). More specifically, these intervals reflect the extent to which sampling error remained in the sample-size weighted mean correlations. Heterogeneous confidence intervals are wider than homogeneous confidence intervals because they assume effect sizes (in this case correlations) are heterogeneous or come from different populations. As a result, a larger standard error is used. These intervals mean that there is a 95% chance that this interval includes the sample-size weighted mean correlation.

After this was completed, correlations from all of the individual samples were corrected for measurement error in the occupational stressor measure. The purpose of correction for measurement error is to estimate a population correlation (ρ) for each occupational stressor-sleepiness/sleepiness surrogate relationship. Variance corrected for measurement error (σ_ρ^2) was also calculated. This variability is calculated after corrections were made. In cases where reliability information for the occupational stressor measure was not available, corrections were made based on averages of the reliabilities derived from the included studies.

Correction was not completed for measurement error in the sleepiness/sleepiness surrogate measure. Correction for measurement errors are made using reliability estimates. Internal consistency reliability was the type of reliability reported in all of the studies included in this meta-analysis. However, there is reason to believe that one would not want the items on a sleepiness/sleepiness surrogate measure to be internally consistent, because sleepiness/sleepiness surrogate measures are causal and are not effect indicator measures. According to Bollen and Lennox (1991), an effect indicator measure is one in which each item is assumed to represent a solitary construct. For this type of measure a scale of internal consistency is an appropriate measure of reliability. Internal consistency indices assume that items should be interchangeable. A causal indicator measure is comprised of conceptually distinct components. The items are not all indicative of the same underlying construct but they are often highly related. To illustrate this one might think of a sleep quality scale. This scale might include items about nightmares (i.e. I have nightmares) and about how long it takes someone to fall asleep once he/she is in bed (i.e. I spend a long trying to get to sleep at night). It is possible for someone to have nightmares and not have trouble falling asleep or have trouble falling asleep but not have nightmares. These items are definitely not interchangeable, so internal consistency is not the appropriate reliability index. Again this is why corrections for measurement error were not made in sleepiness/sleepiness surrogate measures.

A 95% credibility interval was reported to determine whether or not moderators were operating in any of the stressor-sleepiness/sleepiness surrogates relationship

(Whitener, 1990). Two other tests were used to provide additional evidence that moderators might be operating. The first was the 75% rule (Hunter & Schmidt, 1990). For this test the existence of moderators is suggested if less than 75% of the variance in correlations is accounted for by sampling errors. The final test, the chi-square test of homogeneity, investigated whether or not all of the correlations came from the same population. Significance of this test suggests the existence of moderator variables. In other words, a significant chi-square test indicates that the variation in correlations can be attributed to one or more moderators. Because the above statistics do not always converge, the majority of these tests (2 out of 3) was employed to determine the existence of moderators.

In some cases multiple correlations were reported from one sample. When this occurred correlations were averaged as recommended by Hunter and Schmidt (1990). Reliability in these cases was an average of the correlations, and the smallest sample size associated with any of the averaged correlations was used. Please see Table 1 for a complete listing of the included correlations and the relevant data associated with these correlations.

CHAPTER III

RESULTS

In this section, tests of the hypotheses will be reported first followed by tests for potential moderator variables. The results of this study are summarized in Table 2. Table 2 displays sample sizes (n), number of correlations (k), average correlations, sample-size weighted mean correlations ($\bar{r}$), sample-size weighted variance (s_r^2), heterogeneous and homogeneous confidence intervals for these correlations, correlations (ρ) corrected for unreliability of the predictor, the variance of corrected correlation coefficient (σ_ρ^2), credibility intervals, percentage of variance accounted for by sampling error, and the chi-square test.

In the first step of the data analysis hypotheses 1, 2, 3, 4, 5, and 6 were tested. Hypothesis 7 for the relationship between traumatic stressors and sleepiness/sleepiness surrogates was not tested because less than three relevant data points were obtained. The sample-size weighted mean correlations ($\bar{r}$) shown on Table 2 provide support for all of the tested hypotheses. As hypothesized role ambiguity, role conflict, workload, interpersonal conflict, and situational constraints were positively correlated with sleepiness and perceived control was negatively correlated to sleepiness. The sample-size weighted variances show that the individual correlation coefficients do not deviate much from the sample-size weighted mean correlations. The variances associated with

interpersonal conflict and situational constraints were set to be zero due to negative values.

The corrected correlations (ρ) included in Table 2 estimated the population relationships between these different occupational stressors and workplace sleepiness. A corrected correlation as high as .34 was seen for the relationship between workload and workplace sleepiness. Both 95% homogeneous and heterogeneous confidence intervals were also reported in Table 2. Among the heterogeneous confidence intervals the widest was that for workload (.18). The low end of this interval is .20, which is still a relatively sizeable correlation. None of the confidence intervals for those stressors that were hypothesized to have positive relationships with sleepiness (or sleepiness surrogates) contain zero let alone a negative value. This indicates that even when taking into account sampling error, one can be relatively confident that there is a positive relationship between any of these occupational stressors and surrogates of workplace sleepiness. A negative relationship was hypothesized between perceived control and workplace sleepiness (or its surrogates). The heterogeneous confidence interval does not include zero nor a positive value. As with the other predictors, this provides evidence that the hypothesized direction of the relationship is correct. It is noted that the average weighted correlations for role ambiguity, role conflict, interpersonal conflict, and situational constraints were based on few correlations (8, 3, 7, and 8 respectively). Hence, the results should be interpreted with caution.

The next step in analyzing this data was to assess whether moderator variables might be operating. Multiple analyses were done including, credibility intervals, calculations of the percentage of variance accounted for by sampling error (PVA_{SE}), and the chi-square tests for homogeneity for uncorrected (χ^2) correlations (see Table 2). The existence of moderators is suggested by credibility intervals including zero. Only two of the credibility intervals included zero, which suggests the existence of moderators only for workload and perceived control. The variances associated with ρ were zero for role conflict, interpersonal conflict, and situational constraints. As in the case of sample-size weighted variance these values were negative and set to zero. This lack of variability resulted in credibility intervals that were non-existent (i.e., .18-.18). After all, the calculation for a credibility interval is based on σ_ρ^2 ($\rho \pm 1.96\sigma_\rho$). Next, percentages of variance accounted for by sampling error were examined. . The existence of moderators is suggested when less than 75% of the variance in correlations is accounted for by sampling error. Contrary to what was found with credibility intervals, moderators were suggested for role ambiguity, workload, and perceived control. With regard to the chi-square tests, significant results suggest that there are moderators operating. In the present study, the chi-square tests were significant for workload, perceived control, and role ambiguity. Overall, all three tests indicated the existence of moderators for both workload and perceived control. Moderator analysis was conducted for workload, but

not for perceived control based on the small number of correlations (there would have been fewer than 3 data points in a cell once the studies were subdivided). There also was evidence for the existence of moderators in the case of role ambiguity (2 of the 3 test for moderators indicated their existence). As with perceived control, there were too few correlations to make a moderator analysis meaningful.

The only moderator that was possible to investigate was type of sleepiness/sleepiness surrogate measure. It was not possible to investigate specific workload measure as a moderator because there was great variability in measures used. This variability resulted in too few data points in each type of measure to have even a moderate level of statistical power. The type of sample was also not examined as a moderator because there was only one correlation that came from a military sample.

Regression was conducted to test whether type of sleepiness/sleepiness surrogate measure moderated the relationship between workload and sleepiness. Type of sleepiness/sleepiness surrogate measure was a categorical variable with four types of sleepiness/sleepiness surrogate measures, which included sleep quantity, sleep quality, fatigue, and psychosomatic symptoms. The regression analysis produced a non-significant result, $F(3,19)= 1.37$, $p>.05$. In conjunction with this moderator analysis separate meta-analyses for each of the measure types were also conducted and presented in Table 3.

It should be noted that the percentages of variance accounted for by sampling error for the relationship between role conflict, interpersonal conflict, situational constraints and workplace sleepiness were all over 100% (see Table 2). These values were set at 100% because a percentage greater than 100 is nonsensical. Furthermore, Hunter and Schmidt (1990) noted that percentages of variance greater than 100% are a result of second-order sampling error. Second-order sampling error is referred to as the extent to which "studies randomly happen to be available." (Hunter & Schmidt, 1990, p. 411). In other words, this form of sampling error is present when the available studies are not completely randomly distributed. Therefore, the sample-size weighted mean correlations and the standard deviations may differ from the sample-size weighted mean correlations for a random selection of studies. One type of second-order sampling error of particular concern is publication bias. This type of bias occurs when studies with larger and often times only significant results get published, and as a result create a biased pool of data points to draw from. As suggested by Rothstein, McDaniel, and Borenstein (2002), funnel plots were created to assess the distribution of the data points as shown in Figures 2a-2b. A funnel plot was not created for role conflict because there were too few data points (three) to make the plot informative. These funnel plots are created by plotting points on a graph with the y-axis representing sample size and the x-axis representing uncorrected correlations. According to Rothstein, McDaniel, and Borenstein (2002), "if there is no publication bias the effect size estimates from the small studies will be broadly scattered across the bottom of the graph, with less scatter as the

sample sizes increase." Publication bias is indicated when there is a negative skew. In other words, there will be asymmetry in the bottom portion of the plot with few data points representing smaller correlations with small sample sizes. It should be noted that this type of asymmetry may not be the result of publication bias, but rather other types of retrieval biases and true heterogeneity of studies. These plots at the very least give some indication of where publication bias might be a concern. Figure 2a has a distribution that approximates a normal curve. Figure 2b has definite gap in the bottom left corner of the plot. This may indicate publication bias.

File drawer analyses were conducted next to determine to what extent missing null-findings might affect the study results. These analyses calculate the number of missing studies with null findings that would have to exist to reduce the sample-size weighted mean correlations to a non-significant level. For the purposes of these analyses the level that was chose was a correlation of .01. The numbers of missing studies with null findings required to do this were 144, 45, 728, 112, 144, and 104 for role ambiguity, role conflict, workload, interpersonal conflict, situational constraints and perceived control, respectively. These numbers are quite large, and as a result it does not seem there were enough missing studies to significantly change the conclusions. It should be noted that moderators were suggested for the relationships between role ambiguity, workload, perceived control and sleepiness/sleepiness surrogates. File drawer analyses assume a homogeneous collection of studies. As a result the estimates provided here should be interpreted cautiously.

Finally a series of outlier analyses were conducted based Beal, Corey, and Dunlap's (2002) procedure to examine if there were any data points that distorted the results. Beal, Corey, and Dunlap suggested that outliers were any data points that had sample adjusted meta-analytic deviancy (SAMD) values greater than +/- 2.0. Outliers were identified for both the relationships between workload and perceived control with sleepiness/sleepiness surrogates. Specifically, there were eleven outliers amongst the workload-sleepiness data points and three amongst the perceived control-sleepiness data points, as indicated in Table 1. Meta-analysis was conducted again for workload and perceived control after removing the outliers. The results are described in Table 4. On a whole, the relationship between perceived control and sleepiness/sleepiness surrogates did not change substantially. However, the changes there were some noteworthy changes in the relationship between workload and sleepiness/sleepiness surrogates. The sample size-weighted mean correlation went from 0.29 to 0.22, and rho went from 0.34 to 0.24 when the outliers were eliminated. Further, the presence of moderators was not suggested. Further, the PVA_{SE} was set to be 100%, which suggests a possible problem with of second order sampling error. A funnel plot was created to investigate this possibility (See Figure 3). The plot does not have a perfectly bell shaped curve. There are a large number of data points with correlations between 0.15 and 0.25 and sample sizes of 300 or less. There seem to be no extreme values. This may represent publication bias but does not seem to be a clear-cut case of bias.

CHAPTER IV

DISCUSSION

Workplace sleepiness is of critical importance to employers. Sleepiness causes difficulty concentrating, performance decrements, and memory lapses (Webb & Cartwright, 1978). These deficits translate into lost productivity and quite often, serious accidents and injuries, both of which are extremely costly to employers. As a result, it is important to explore possible antecedents of workplace sleepiness, in order to prevent negative outcomes. As previously noted, there has been little systematic research on work place sleepiness. A qualitative review of the existing literature (Krauss, et al., 2003) led to the current meta-analysis. This review suggested a relationship between occupational stressors and workplace sleepiness. The results of this quantitative review support this idea, and opens a fruitful area of research within the occupational health realm. While the current findings are cross-sectional and cannot provide proof of a causal relationship, they do suggest that investigating such a relationship with the appropriate research design might be worthwhile. If a causal relationship can be substantiated, further credence would be provided to employers and employees about the importance of occupational health.

It is important to take steps toward uncovering possible causal relationships within occupational health,, because strong evidence can provide avenues for intervention. It is often difficult to convince management and higher administration of the importance of occupational health. If a causal path can be drawn from occupational

stressors to workplace sleepiness, which may lead to important organizational outcomes (i.e. productivity, accidents, injuries), then perhaps management would be more inclined to take an active role in managing employee stress.

As can be seen in the results there are relatively sizeable relationships between the occupational stressors and sleepiness surrogates. The weakest relationship was that between perceived control and sleepiness ($\bar{r}$ = -.09 ρ= -.10); while the strongest relationship was seen between workload and workplace sleepiness ($\bar{r}$ = .29 ρ= .34). The latter finding seems intuitive. After all, one would assume that having to work harder or for greater lengths of time would make someone sleepy. It should be emphasized that workplace sleepiness may be affected by many individual characteristics (i.e. morningness-eveningness orientation, health conditions, neuroticism) and organizational factors (i.e. monotony, physical environment, changes in schedule). Further these types of variables may interact in ways to affect sleepiness. For instance, monotony might interact with workload such that those with highly monotonous jobs always experience high rates of sleepiness, but those that have low monotony jobs only experience increased sleepiness with increased workload. Therefore, one should not expect relationships between these variables and sleepiness to be extremely strong. Nonetheless, the overall size of relationships observed in the meta-analysis was large enough to suggest potential adverse contributions of occupational stressors to workplace sleepiness.

In the case of some of the relationships with occupational stressors including workload, perceived control, and role ambiguity, moderator variables appear to be

operating; yet the one moderated regression analysis that was conducted was not signficant. This may have been due to insufficient power. A post-hoc power analysis was conducted, and it appeared to be low, with only a 30.4% chance of detecting differences between groups. This is not surprising in light of the fact that there were few correlations for each category when these cells were further subdivided (i.e. there were only two correlations that used sleep quality as the outcome measure). Table 3 shows that there was variation in sample-size-weighted correlations when the workload studies were subdivided by sleepiness measure type. The values range from 0.12 (for sleep quality) to 0.49 (for sleep quantity). Based on these results and those of the power analysis, it seems quite possible that this might have been a significant moderator of the relationship with a larger number of correlations. It is also clear that workload is more strongly related to some sleepiness/sleepiness surrogates than others. Specifically workload is more strongly related to sleep quantity and fatigue than psychosomatic symptoms and sleep quality. This highlights the complexity of the relationship between occupational stressors and workplace sleepiness. This relationship appears even more complex upon examination of the credibility intervals, PVA_{se}s, and χ^2s. It is quite clear that there may be additional moderators of the workload-workplace sleepiness relationship (2 or more of these tests indicate the existence of moderators for sleep quantity, fatigue, and psychosomatic symptoms). It is also notable that the PVA_{se} for sleep quality is 100%. This indicates that there may be a problem with second-order sampling error; however, the funnel plot could not offer any insight due to few

correlations being available. These findings stress the need for future studies that explore the complex relationship between occupational stressors and workplace sleepiness.

Limitations

The current meta-analysis had a number of limitations. The first and perhaps greatest limitation was the fact that sleepiness surrogates had to be used. There was little published research which measured workplace sleepiness directly. As a result measures of sleep quantity, sleep quality, fatigue, and psychosomatic symptoms were used as proxies for workplace sleepiness. In doing this, several assumptions were made. First that a person's sleep quantity and quality at night impacts his/her subsequent alertness (or sleepiness) at work. Second, that measures of fatigue and sleep-related psychosomatic symptoms were highly related to measures of workplace sleepiness. While this is not ideal, there is strong evidence that these surrogates are appropriate stand-ins for sleepiness (Pilcher et al., 2000, Rogers et al., 1993, Michielsen et al., 2003, & Spector & Jex, 1998). Further, the reader is reminded that this meta-analysis merely aims to provide a preliminary description of the nature of the relationships between occupational stressors and workplace sleepiness. It has been said throughout this paper that workplace sleepiness is an under-researched area. It is hoped that these initial results will be used by occupational health researchers to further research this important topic.

The second limitation was the limited number of correlations. Generally speaking there were not large numbers of correlations for any of the stressors and sleepiness/sleepiness surrogates. As previously noted, there were only eight correlations

for both role ambiguity and situational constraints, seven for interpersonal conflict, and three for role conflict. This was the result of fewer studies existing for these predictors, and the difficulty in accessing those that are in existence. The relationships between these occupational stressors and sleepiness (or sleepiness surrogates) seem to have been researched less. Quite frequently authors had to be contacted for additional information. It should be noted in Figure 1 that a number of studies were not included as a result of not being able to get this information (authors could not access the data, authors did not have time to provide the information, authors did not respond, authors could not be found). Little can be done to alleviate these problems. However, future researchers attempting to complete a similar meta-analysis might limit included studies to those completed in the past 20 years. It should be recognized that authors still might have problems accessing data from this time period, yet this is probably the oldest data that researchers can still access. Despite the limited numbers, file drawer analyses demonstrated that a large number of null findings would have to exist in order to change the conclusions of this study.

Often meta-analyses are criticized for not including unpublished studies. The current meta-analysis included some unpublished work (See Table 1). Dissertations and theses were investigated for relevance when they could be obtained. Most did not provide relevant information. Authors of the few that did were contacted. Very few authors responded and provided requested recalculations of their data. Upon a request for their published work, a few prominent stress researchers provided unpublished work.

Ideally an additional moderator (publication status) should be investigated to ensure that publication status did not affect the correlations. However, there were too few unpublished data points associated with each stressor to provide for a meaningful analysis.

The current research has spoken of occupational stressors as possible antecedents of workplace sleepiness. However, it is noted here that the current data does not prove causality. For instance, it is possible that workplace sleepiness actually induces occupational stressors, or that there is some type of feedback loop where more stressors cause more sleepiness, which in turn creates more stressors. Experimental and longitudinal research would be helpful to better understand the causal paths between these variables. Further research that investigates potential mediators of the relationship between occupational stressors and workplace sleepiness would also be helpful. In the current meta-analysis some of these mediators are already suggested. Perhaps the relationship between interpersonal conflict and workplace sleepiness is mediated by sleep quality. For instance, those who have more interpersonal conflict might also have more restless sleep, more nightmares, more trouble falling asleep (poor sleep quality). As a result of reduced sleep quality, these individuals may be sleepier at work the next day. Research determining how occupational stressors affect sleepiness (if this is in fact the causal direction) is needed.

Future Directions

This meta-analysis is of a highly exploratory nature. This quantitative review synthesizes much of the occupational stressors-sleepiness research (i.e. sleep, medicine, ergonomics, occupational health, etc.) in an effort to provide future research directions. It is quite obvious from the limited number of correlations retrieved from the literature that more research on workplace sleepiness is needed. Research that directly investigates workplace sleepiness and not just surrogates is needed. There are a number of sleepiness measures in existence (i.e. ESS, SWAI, SSS) that researchers could adapt for work related studies. It may also be helpful to create a workplace sleepiness measure. In addition, more studies investigating moderators of these relationships need to be completed.

Conclusion

Based on this study, it appears that as stressors increase so to does sleepiness. The 2002 National Sleep Foundation poll revealed that many people felt that a lack of sleep influenced their safety at work. This observation coupled with knowledge of the negative consequences of sleepiness (i.e. accidents, injuries, fatalities, poor job performance), indicates a need for practitioners and researchers to pay attention to workplace sleepiness and its antecedents.

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Table 1

Data for included studies

Study	Rxx	Type of Sleepiness Measure[a]	n	r
Role ambiguity				
Spector & Jex (1991)		Symptoms*	232	0.27
Spector, Chen & O'Connell, 2000	0.80	Symptoms*	110	0.02
Spector, Dwyer & Jex, 1988	0.71	Symptoms*	156	0.06
Pollard, 2001	0.79	Symptoms*	198	0.28
Hellgren & Sverke, 2001	0.78	Symptoms*	569	0.23
Chen & Spector, 1991	0.82	Symptoms*	393	0.21
Jex, Burnfield, Grauer, Lax, Roelse & Sroda, 2003[a]	0.80	Symptoms*	239	0.08
Jex, Burnfield, Grauer, Adams & Morgan, 2003[a]	0.77	Symptoms*	197	0.18
Role conflict				
Chen & Spector, 1991	0.81	Symptoms*	391	0.19
Jex, Burnfield, Grauer, Adams & Morgan, 2003[a]	0.82	Symptoms*	197	0.19
Spector, Chen & O'Connell, 2000	0.80	Symptoms*	110	0.02
Workload				
Landsbergis, 1988	0.71	Quality	239	0.20
Zohar, 1999	0.92	Fatigue& Quantity	205	0.17
Spector, Fox & Van Katwyk, 1999		Symptoms*	111	0.20
Spector & Jex (1991)		Symptoms*	231	0.24
Spector, Chen & O'Connell, 2000	0.84	Symptoms*	110	0.16

Spector, Dwyer & Jex, 1988		Symptoms*	150	0.17
Beehr, Glaser, Canali & Wallwey, 2001	0.69	Symptoms*	108	0.24
DeCroon, Van Der Beek, Blonk & Frings-Dersen, 2000	0.84	Symptoms*	514	0.43[b]
Widerszal-Bazyl, Cooper, Sparks & Spector, 2000	0.83	Fatigue	248	0.10[b]
De Croon, 2003[a]	0.88	Fatigue	1181	0.44[b]
Schreurs & Taris, 1998	0.78	Fatigue	179	0.16
Schreurs & Taris, 1998	0.78	Fatigue	302	0.31
Shirom, Westman, Shamai & Carel, 1997	0.88	Fatigue	194	0.19
Kageyama, Nishikido, Kobayashi & Kawagoe, 2001		Quantity	283	0.25
Samel, Wegmann & Vejvoda, 1997		Fatigue	50	0.88[b]
Tummers, Landerweerd & vanMerode, 2002	0.87	Symptoms*	155	0.25
Tanz & Charrow, 1993		Quantity	1355	0.75[b]
Lee, 1992		Quantity	733	0.12[b]
Hellgren & Sverke, 2001	0.79	Symptoms*	569	0.23
Parkes, 2003	0.85	Symptoms* & Quality	1440	0.09[b]
Chen & Spector, 1991	0.87	Symptoms*	390	0.10[b]
Jex, Burnfield, Grauer, Adams & Morgan, 2003[a]		Symptoms*	197	0.18
Jex, Burnfield, Grauer, Lax, Roelse & Sroda, 2003[a]	0.88	Symptoms*	238	0.21

Galambos & Walters, 1992		Quality	96	0.07[b]
Galambos & Walters, 1992		Quality	96	0.05[b]
Fortunato & Harsh, 2004[a]	0.83	Quality	467	0.10[b]
Interpersonal Conflict				
Spector, Fox & Van Katwyk, 1999		Symptoms*	111	0.26
Spector, Chen & O'Connell, 2000	0.72	Symptoms*	110	0.12
Spector, Dwyer & Jex, 1988	0.81	Symptoms*	154	0.22
Chen & Spector, 1991	0.71	Symptoms*	388	0.18
Jex, Burnfield, Grauer, Adams & Morgan, 2003[a]	0.88	Symptoms*	197	0.07
Jex, Burnfield, Grauer, Lax, Roelse & Sroda, 2003[a]	0.86	Symptoms*	239	0.15
Fortunato & Harsh, 2004[a]	0.80	Quality	467	0.18
Situational Constraints				
Zohar, 1999	0.86	Fatigue	205	0.21
Spector, Fox & Van Katwyk, 1999		Symptoms*	113	0.22
Spector, Chen & O'Connell, 2000	0.85	Symptoms*	110	0.08
Spector, Dwyer & Jex, 1988	0.84	Symptoms*	156	0.24
Hellgren & Sverke, 2001	0.84	Symptoms*	569	0.15
Chen & Spector, 1991	0.87	Symptoms*	391	0.25
Jex, Burnfield, Grauer, Adams & Morgan, 2003[a]	0.88	Symptoms*	197	0.16

Jex, Burnfield, Grauer, Lax, Roelse & Sroda, 2003[a]	0.87	Symptoms*	238	0.20
Perceived Control				
Landsbergis, 1988	0.80	Quality	239	-0.13
Spector, Fox & Van Katwyk, 1999	0.77	Symptoms*	112	0.07[b]
Spector & Jex (1991)	0.87	Symptoms*	231	-0.004
Spector, Chen & O'Connell, 2000	0.80	Symptoms*	110	0.02
Spector, Dwyer & Jex, 1988	0.70	Symptoms*	156	-0.09
Beehr, Glaser, Canali & Wallwey, 2001	0.81	Symptoms*	115	0.06
DeCroon, Van Der Beek, Blonk & Frings-Dresen, 2000	0.72	Symptoms*	514	-0.22[b]
De Croon, 2003[a]	0.89	Fatigue & Quality	673	-0.29
Schreurs & Taris, 1998	0.70	Fatigue	179	0.01
Schreurs & Taris, 1998	0.70	Fatigue	302	0.03[b]
Edwards & Rothbard, 1999		Symptoms*	1655	-0.09
Tummers, Landeweerd & vanMerode, 2002	0.84	Symptoms*	155	-0.17
Parkes, 2003	0.70	Symptoms* & Quality	1440	-0.13

Note. Symptoms=Psychosomatic Symptoms, Quantity=Sleep Quantity, Quality=Sleep Quality, Rxx=Reliability of the stressor measure; all reliability coefficients are alpha coefficients, r=correlation coefficient, n=sample size

* Author calculated correlation between the stressor and the sleep related symptoms

[a] Unpublished work

[b] Data point was identified as an outlier

Table 2

Meta-Analysis of the Relationships Between Occupational Stressors and Workplace Sleepiness

Predictor	n	k	$\bar{r}$	s_r^2	Heterogeneous Confidence Interval	Homogeneous Confidence Interval	ρ	σ_ρ^2	Credibility Interval	PVA_{SE}	χ^2(df)
R.Ambiguity	2,094	8	.19	.006	.13-.24	.15-.23	.21	.004	.10-.33	57%	14.20(7)*
R. Conflict	698	3	.16	.004	.09-.24	.09-.24	.18	.000	.18-.18	100%[a]	2.97(2)
Workload	9,841	26	.29	.050	.20-.38	.27-.31	.34	.066	-.16-.84	4%	587.55 (25)*
Int. Conflict	1666	7	.17	.000	.12-.21	.12-.21	.23	.000	.23-.23	100%[a]	4.21(6)
Sit. Const.	1979	8	.19	.000	.15-.23	.15-.23	.21	.000	.21-.21	100%[a]	4.77(7)
P Cont.	5,881	13	-.09	.009	-.14- -.03	-.11- -.06	-.10	.009	-.29-.09	23%	56.36(12)*

Note. R.Ambiguity= Role Ambiguity, R. Conflict=Role Conflict, Int. Conflict=Interpersonal Conflict, Sit. Const. =Situational Constraints, P Cont.=Perceived Control; n=total number of participants, k=total number of correlations, $\bar{r}$ = sample-size-weighted correlation, s_r^2 =sample-size weighted variance, ρ= correlation corrected for unreliability in the predictor, σ_ρ^2 = Variance of rho, PVA_{SE} = percentage of variance accounted for by sampling error, χ^2= chi-square tests for homogeneity for uncorrected correlations

[a] Actual percentage of variance accounted for by sampling error was greater than 100% but was set to 100% as suggested by Hunter & Schmidt (1990)

*significant at p<.05

Table 3

Workload Meta-Analysis Subdivided by Type of Sleepiness/Sleepiness Surrogate Measure

Type of Measure	n	k	$\bar{r}$	s_r^2	Heterogeneous Confidence Interval	Homogeneous Confidence Interval	ρ	σ_ρ^2	Credibility Interval	PVA_{SE}	χ^2(df)
Sleep Quantity	2371	3	.49	.09	.16-.83	.46-.52	N/A	N/A	N/A	1%	369.12(3)*
Sleep Quality	898	4	.12	.00	.05-.18	.05-.18	.13	.00	.13-.13	100%[a]	2.49(3)
Fatigue	2154	6	.35	.02	.22-.47	.31-.38	.38	.03	.06-.70	9%	66.37 (5)*
Psychosomatic Symptoms	2773	11	.24	.01	.18-.30	.20-.27	.26	.01	.09-44	35%	31.91(10)*

Note. n=total number of participants, k=total number of correlations, $\bar{r}$ = sample-size-weighted correlation, s_r^2 =sample-size weighted variance, ρ= correlation corrected for unreliability in the predictor, σ_ρ^2 = Variance of rho, PVA_{SE} = percentage of variance accounted for by sampling error, χ^2= chi-square tests for homogeneity for uncorrected correlations; N/A=Not applicable because reliability information was not available for any of these data points

[a] Actual percentage of variance accounted for by sampling error was greater than 100% but was set to 100% as suggested by Hunter & Schmidt (1990)

*significant at $p<.05$

Table 4

Meta-Analysis of the Relationships Between Occupational Stressors and Workplace Sleepiness with Outliers Eliminated

Predictor	n	k	$\bar{r}$	s_r^2	Heterogeneous Confidence Interval	Homogeneous Confidence Interval	ρ	σ_ρ^2	Credibility Interval	PVA_{SE}	χ^2(df)
Workload	3,271	15	.22	.002	.19-.25	.19-.25	.24	.000	.24-.24	100%[a]	6.27 (14)
P Cont.	4,953	10	-.08	.008	-.14- -.03	-.11- -.06	-.13	.014	-.35- .10	25%	40.77(9)*

Note. P Cont.=Perceived Control; n=total number of participants, k=total number of correlations, $\bar{r}$ = sample-size-weighted correlation, s_r^2=sample-size weighted variance, ρ= correlation corrected for unreliability in the predictor, σ_ρ^2 = Variance of rho, PVA_{SE} = percentage of variance accounted for by sampling error, χ^2= chi-square tests for homogeneity for uncorrected correlations

[a] Actual percentage of variance accounted for by sampling error was greater than 100% but was set to 100% as suggested by Hunter & Schmidt (1990)

*significant at $p<.05$

Figure 1. Flow Chart Describing the Reduction of Studies

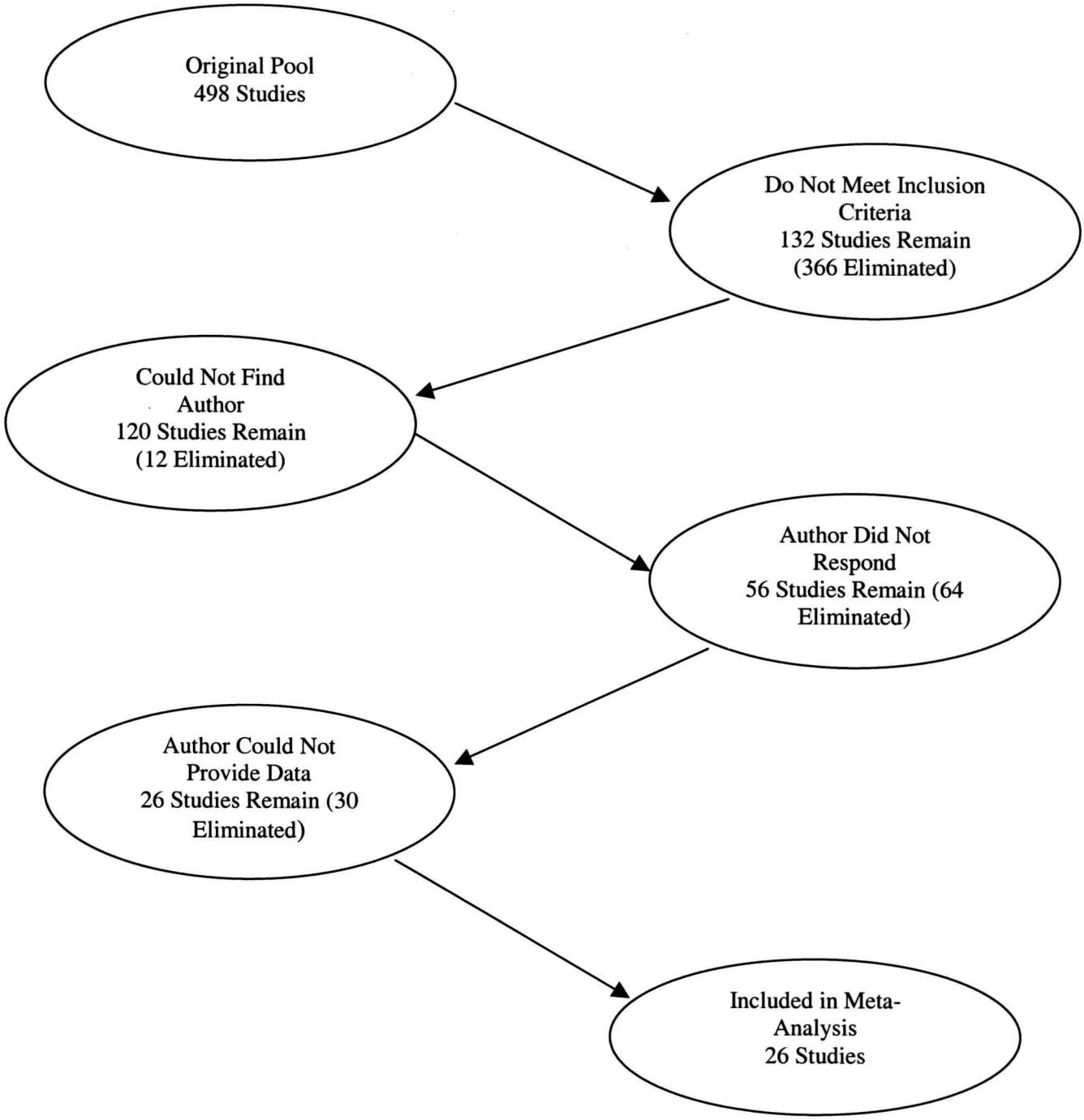
Original Pool
498 Studies
Do Not Meet Inclusion Criteria
132 Studies Remain
(366 Eliminated)
Could Not Find Author
120 Studies Remain
(12 Eliminated)
Author Did Not Respond
56 Studies Remain (64 Eliminated)
Author Could Not Provide Data
26 Studies Remain (30 Eliminated)
Included in Meta-Analysis
26 Studies

Figure 2a. Funnel plot for Interpersonal Conflict

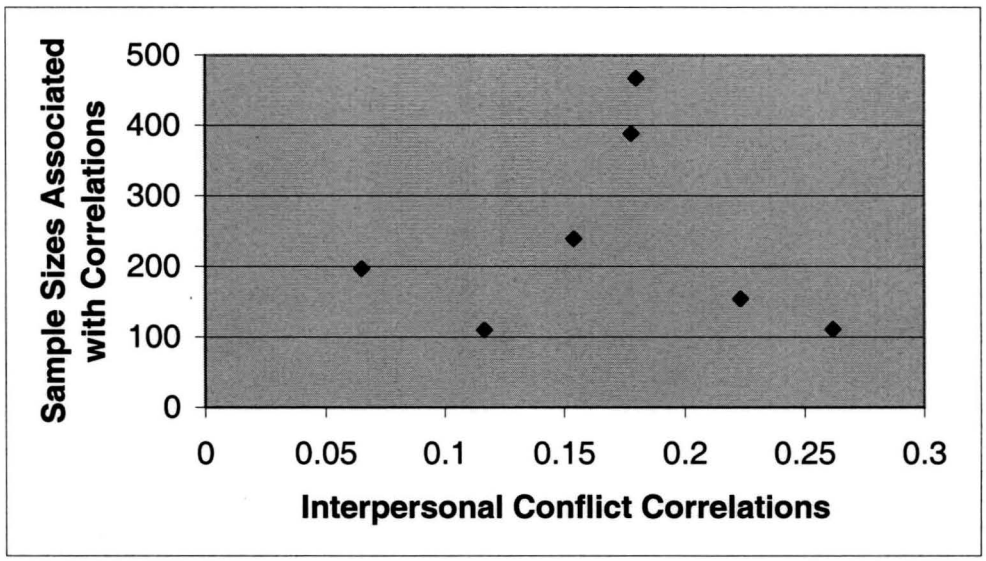

Figure 2b. Funnel plot for Situational Constraints

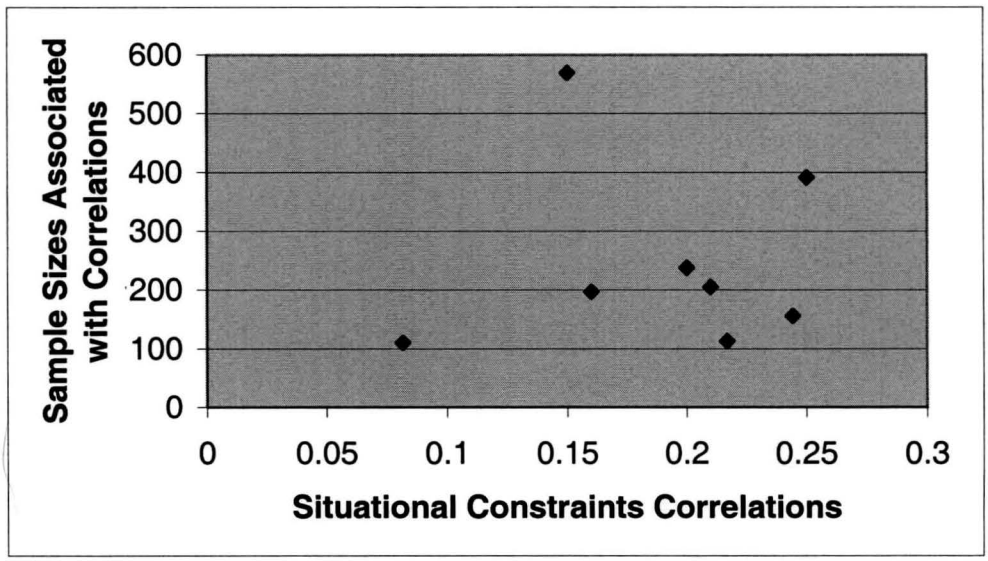

Figure 3. Funnel plot for Workload Without Outliers