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Workforce Productivity: Schedules, Fatigue, & Health
On Female Intermodal Transportation Workers

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ABSTRACT

The present study was designed to determine the magnitude of the relationship between productivity and the amount, frequency, and length of shift work completed by female transportation employees and the number, degree, and extent of problems related to physical and psychological health including depression. It was hypothesized that long-term productivity impacts may affect transportation professionals engaged in shift work on a regular basis will have place themselves at higher risk for developing health or psychosocial related effects. These health related outcomes can have a profound impact on an employee's job performance, daily functioning, and personal life. The present study sought to understand the potential relationship between working shift work and higher disturbances to the bodies' natural functioning. It was hoped that the study would identify factors that could lead to decreased risk for those doing shift work by adding to the overall understanding of this multifaceted relationship.

The overall purpose of the study was to gain a better understanding of the effects on productivity of shift work on females working within the transportation industry. This study has implications for explaining that the effects of disturbances to the circadian rhythm as a result of certain shift work schedules can result in ill-related health effects. This study sought to explain the health implications specifically for female workers as fewer studies have been conducted with gender as a main effect in the analysis. The present study suggests that due to the circadian rhythm controlling hormone secretion within the body, disturbances to its natural rhythm can have additional effects on female cycles such as menstruation. Overall, this study offers implications for further research on females working shift work and highlights the continued importance for further exploration into recent developments. These implications have the potential to further our current understanding of the relationship between shift work and ill-health effects, particularly the factors that women face.

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1. Introduction

The American modern economy demands a 24 hour-7 day a week schedule for production of services. There is therefore a national need for a number of individuals to work "shift work" hours to help meet these demands. As of 2004, 15% of the American workforce, or roughly 8.5 million Americans, were engaged in some sort of shift work (Chung, Wolf, and Shapiro, 2009). Shift work will hereafter be defined as working any hours outside of 7AM to 6PM. There are a number of occupations and sectors that demand this type of labor. The transportation industry, military, and health care are examples of workforce sectors that all demand the need for individuals to work around the clock. Often times working shift work can be a choice by the individual, but many times it is a requirement of the occupation that the individual is working within.

A recent *Sleep in America Poll* (Johnson, et. al 2014) found that pilots cited the longest average shift on the job at 10.4 hours which was significantly longer than members of the control group (8.5 hours), rail transportation workers (9.8 hours) and bus/taxi or limo drivers (7.2 hours). Truck drivers (10.1 hours) and rail transportation workers (9.8 hours) average shift lengths which were significantly longer than the control group (8.5 hours) and bus/taxi or limo drivers (7.2 hours). In addition, members of the control group of (N=292) in comparison to transportation professionals were less likely to work the same schedule each day (76% vs. 61% bus/taxi or limo drivers, 51% truck drivers, 47% rail transportation workers and 6% pilots). The control group was also significantly more likely to work the same days each week as compared to each of the transportation professions (82% vs. 74% bus/taxi or limo drivers, 67% truck drivers, 55% rail transportation workers and 10% pilots). (Johnson, et. al 2014).

It has been well documented that working when the body would typically be sleeping and forcing the body to sleep when it would typically be awake can have profound negative physical effects on the body (Costa, 2003). The human body is run by a series of physiological processes that regulate natural human functioning. Specifically, the circadian rhythm plays an overarching major role in regulating a number of human functions; it also corresponds with our natural sleep cycle. When our circadian rhythm is affected, we inadvertently deregulate our natural sleep cycles and vice versa. The circadian rhythm plays a role in a number of functions in the human body. In addition to regulating our sleep, it controls hormone secretion in our body that, when maladapted, can have physical effects on our bodies. The circadian rhythm has also been theorized to regulate body temperature, blood pressure, and have some effect on the bodies' appetite (Dean, Fletcher, Hursch, and Klerman, 2007).

Shift work can require an individual to work long and irregular hours that can cause distinct interruptions to the natural sleeping pattern. As noted earlier, pilots reported working the same schedule on 10% of the time (Johnson, et. al, 2014). Often shift work requires an individual to work overnight or wake up very early in the morning to begin working when the body would typically still feel a natural urge to be asleep. The bodies' natural tendency to want to sleep often falls within the hours of midnight and 6AM. When an individual is forced to work during these hours or wake up during these hours to report to work, there is increased risk for disturbances to the natural sleep wake cycle. As discussed, the sleep wake cycle coincides and syncs with the bodies' natural circadian rhythm. Working shift work can therefore potentially deregulate both cycles.

In addition to physical deregulation of cycles, shift work can have potentially negative effects on psychosocial rhythms. Working at times when the body would normally be asleep causes changes to sleeping when the body would normally be awake. There is potential risk for interfering in normal family and social functioning. Enough deregulation to an individual's family and social routine can lead to additional negative impacts such as increased stress, depression, and decline in interpersonal relationships.

1.1. Statement of the Problem

Transportation professionals who are working shift work on a regular basis place themselves at higher risk for developing health or psychosocial related effects. These health related outcomes can have a profound impact on an employee's job performance, daily functioning, and personal life. Understanding potential risk factors, as well as health practices for avoiding higher disturbances to the bodies' circadian rhythm, are essential to aid in the maintaining of physical and psychological well being of these individuals as well as improving their overall productivity. Time away from work due to health effects, as well as decreased productivity due to changes in mood and depression may contribute negatively to overall productivity.

Deregulation of the circadian rhythm can cause disturbances to sleep but also disturbances to other systems that the rhythm regulates. Body temperature, appetite, and blood pressure are examples of areas of human functioning that can be affected from working shift work. There is an extensive amount of research (Reinberg & Ashkenazi, 2008, Barton, 1994; Costa, 2003) to indicate that these affected areas can lead to serious physical health problems. Chronic fatigue, cardiovascular disease, obesity, and depression are among some examples that have been documented as resulting in working shift work.

Prior research (e.g. Costa, 2003; Dean et al., 2007) has indicated that both men and women are subject to ill-health effects from working shift work. Neither gender is exempt from feeling the effects of disturbances to the circadian rhythm due to disturbances in the sleep wake cycle. There is however a growing amount of research (Reinberg & Ashkenazi, 2008, Barton, 1994; Costa, 2003;) indicating new and additional negative risk for females.

Due to the circadian rhythm controlling hormone secretion within the body, disturbances to its natural rhythm can have effect on female menstrual cycles. There is also some research (eg., Medgal, Kroenke, Laden, Pukkala, and Schernhammer, 2005; Stevens, 2009) indicating that this disturbance can lead to disturbances to fertility and, alarmingly, an increased risk for breast cancer due to hormone deregulation. There is a great need for further exploration into these recent developments to better understand the relationship between shift work and ill-health effects, particularly the additional factors that women face.

1.2. Purpose of Studying the Problem

Several researchers (eg., Akerstedt, 1990; DeKonick, 1997; Reinberg & Ashkenazi, 2008, Barton, 1994; Costa, 2003; Amelsvoort, Shouten, and Kok, 1999; Lin, Hsiao, and Chen, 2009; Culpepper, 2010) have indicated that working shift work can have negative effects on the well being of an individual. There has been research to suggest that women face increasing ill-health effects from working shift work but much more research is needed. (Clayton, 2008, Barzilai-Pesach, Sheiner, Potashnik, and Shoham-Vardi, 2006, Medgal, Kroenke, Laden, Pukkala, and Schernhammer, 2005; Stevens, 2009) There is currently a decent amount of preliminary data to suggest that women experience increased health risk with working shift work when deregulation of the bodies' natural cycles occur. However, the current research is lacking in a distinct understanding of the gender specific issues for a number of reasons. Additionally, there are a number of limitations to the research that has been conducted including but not limited to a small amount of ill-constructed research designs to understand the issues, the majority of studies being conducted on men, and a lack of research designed to understand issues within the transportation sector alone. The overall purpose of this study is to gain a better understanding of the negative effects of shift work on females working within the transportation industry. Research is needed to examine if there are health risk factors for working shift work within the transportation industry, since this concept has not yet been tested with this population.

1.3. Importance of Studying the Problem

There are millions of individuals who utilize America's transportation industry on a daily basis for personal and professional reasons. It is of national importance that this industry is able to operate efficiently and safely. Within that efficiency lies the physical and mental health of the industries' employees. It is also necessary to consider the cost that can result from employee ill-health of operators. Chronic fatigue has been identified as one of the highest predictors of work place related accidents. Accidents in the transportation industry are of particular concern due to their potential for fatality and exorbitant cost. Understanding the issues that can lead to higher instances of fatigue and ultimately, higher risk for work place related accidents, are of national concern.

Research within this area would bring the potential for understanding new ways to decrease the potential risk factors for those working shift work. Identifying what increases risk ill-related health effects will be useful for decreasing risk for these potentially negative outcomes.

1.4. Research Questions and Hypotheses

Research Question 1: Is there a correlation between length of time as a shift worker and increased risk for ill-health effects?

Hypothesis 1: Females who endorse higher numbers of months and years relative to the total amount of shift work on the Survey of Shiftworkers (SOS) will also endorse higher amounts of menstrual disturbances on the Menstrual Distress Questionnaire

(MDQ) as well as higher amounts of depression symptoms on the Center for Epidemiological Studies Depression Scale (CES-D).

Research Question 2: Is there a higher correlation between night work versus mostly day work and increased risk for ill-health effects?

Hypothesis 2: Females who endorse higher numbers of hours relative to the total amount of shift work at night on the Survey of Shiftworkers (SOS) will also endorse higher amounts of menstrual disturbances on the Menstrual Distress Questionnaire (MDQ) as well as higher amounts of depression symptoms on the Center for Epidemiological Studies Depression Scale (CES-D).

Research Question 3: Is there a correlation between shift work and lower instances of reported overall health in females?

Hypothesis 3: Females who endorse higher numbers of hours relative to the total amount of work on the Survey of Shiftworkers (SOS) will receive lower ratings of overall health on the Women's Health Questionnaire (WHQ).

1.5. Definition of Key Terms

Shift Work: A term that refers to any work schedule that encompasses hours outside of the hours of 7AM to 6PM. (Sleep Research Unit at the Institute for Work and Health in Toronto, Chung, Wolf, and Shapiro, 2009).

Night Work: Night shift work has been defined as any shift schedule including overnight work. Airline crew meet this criteria if an individual works flight service that involved circadian rhythm disturbances, exposure to artificial light at night, or experiences of jet lag (Medgal, Kroenke, Laden, Pukkala, and Schernhammer, 2005).

Circadian Rhythm: An innate, daily fluctuation of physiologic and behavioral functions within humans that is generally tied to the 24-hour day-night cycle. The circadian rhythm is a 24-hour process that regulates cycles within our bodies such as body temperature, sleep/wake cycle, and hormone secretion (Stevens, 2009). Hormone production is regulated by the circadian rhythm including: prolactin, melatonin, thyroid-stimulating hormone (TSH), and lutenizing hormone (LH), all of which are linked to reproductive health disturbances (Chung et al., 2003).

Sleep Wake Cycle: The daily sleeping schedule of an individual that describes sleep propensity, sleep maintenance, and times of waking up. The sleep-wake cycle is affected by environmental factors and is meant to coincide with the bodies circadian rhythm (Fukuda, Morita, and Waterhouse, 2012)

Depression: A mood disorder marked diagnostically by either a depressed mood occurring over the course of at least 2 weeks that is accompanied by a loss of interest in most or nearly all normal activities (DMS-IV, 2000).

Menstrual Cycle: A female cycle that is comprised of a complex series of coordinated processes by the hypothalamic, pituitary, and ovarian sectors in the female body. The cycle varies in length and regularity as well as symptomology in every female. The menstrual cycle has been found to be associated with the endocrine function of the female body. Extreme distrupctions to the menstrual cycle have been associated with serious health effects such as infertility and cancer (Small, Manatunga, Klein, Feigelson, Dominguez, McChesney, and Marcus, 2006).

The Women's Health Questionnaire (WHQ) (Hunter, 1988) was first published in 1992. The survey was given to a standardized sample of 1,090 women aged 45-65 years of age who were recruited from an ovarian screening program a King's College Hospital in South London, UK. The WHQ is a 36-item questionnaire assessing nine domains of physical and emotional health rated on four point scales created to determine women's overall emotional and physical health.

The Center for Epidemiologic Studies Depression Scale (CES-D Scale) (Radloff, 1977). The CES-D was developed by the Center for Epidemiologic Studies for use in studies of epidemiology of depression within the general population. The scale is distinct from other depression scales in that the CES-D seeks to measure current levels of depression symptomology versus clinical severity during treatment for example in an individual. The scale was developed on previously validated depression scales and by identification of the following depressive symptomology: depressed mood, feelings of guilt, feelings of worthlessness, feelings of helplessness and hopelessness, psychomotor impairment, loss of appetite, and changes to sleep.

Menstrual Distress Questionnaire (MDQ): The MDQ was developed in 1968 by Rudolph Moos, PhD. The survey is designed to assess the female menstrual cycle and symptomology (Coleman & Stojanovska, 2003). The scale measures eight constructs of menstrual symptomology: pain, concentration, behavioral change, autonomic reactions, water retention, negative affect, arousal, and control.

Survey of Shiftworkers (SOS): The SOS is a shorter version of the original The Standard Shiftwork Index (SSI) (Folkard ,1995) created to address the lack of standardized tools to measure shift-system designs and individual effects from working shift work. It was designed to measure the impact of a variety of shift systems on the health and wellbeing of shift workers. The SOS has a number of scales that include general information on shifts worked, frequency of shifts, timing and duration of shifts, regularity of shifts and workload of shifts. The SSI contains six sections: (1) biographical information and type of shift worked as well as job satisfaction (2) the effect of shiftwork on sleep (3) individual wellbeing including mental health (5) coping with shift work (6) sleeping habits, preference to morning or night, and personality traits of extraversion and neuroticism (Tucker & Knowles, 2008). The SSI theorizes that shift work produces disturbances to the bodies sleep/wake cycle and biological circadian rhythm and psychosocial rhythms.

Epworth Sleepiness Questionnaire (ESS) (Johns, 1991). The EES was developed in 1991 by Murray Johns at Epworth Hospital in Victoria, Australia. The survey was developed with the intention of measuring sleepiness of an individual at a particular time or event. The survey consists of 10 situations in which the subject rates how likely he or she would be to doze off during the given situation (i.e. watching TV or sitting and reading).

2. Previous Research

In 2008, the Sleep Research Unit at the Institute for Work and Health in Toronto defined "shift work" as an individual working outside of the hours of 7am to 6pm (Chung, Wolf, and Shapiro, 2009). Shift work schedules can look very different across occupations. A single shift is normally between 8 to 12 hours in length and can include evening hours, overnight hours, and split shifts. Areas such as transportation, military, restaurant staff, law enforcement, hospitals, and health and safety are just a few examples of the professions that require shift work of some sort. Depending on the work force an individual finds themselves working in, assigned shift work may be permanent or rotate over a given work period, therefore periodically changing the hours worked. Variance can exists between the number of days separating assigned shifts, the time off between shifts, and the mixture of types of shifts assigned (Popkin, Howarth, and Tepes, 2006). Although there is a need for further inquiry, well documented research exists that indicates shift work has negative physiological and social effects on shift workers. Women in the workforce performing shift work deserve special attention and further research within the topic.

As of 2004, 15% of the American workforce, or roughly 8.5 million Americans, were engaged in some sort of shift work (Chung et al., 2009). The reasoning for the majority of men and women working these shifts was not a result of choice, but rather a requirement for the type of job at which they were employed at. Many individuals may find themselves in a position of having to take shift work for promotion, for others it may be strongly influenced by financial need. There are benefits of working shifts work in some instances. Individuals may choose to work shift work to allot more time for things like child and elder care (Shapiro, Helslegrave, Beyers, and Picard, 1997). In a society where labor demands exist around the clock, there is an increasing need for more individuals to work at night, on rotating shifts, and extended night hours (Dean, Fletcher, Hursch, and Klerman, 2007).

Women make up roughly half of the American work force (Chung et al., 2009). The female work force deserves particular attention when occupational demands lead women to working at night and shift work schedules. The physiology of the female body is obviously different than that of a male and therefore working shift work has been found to have different effects when compared to the male co-worker. There are a number of factors that lead to the differences between male and female reactions to shiftwork. The female reproductive ability brings particularly different challenges when a female is faced with sleep deprivation. The health consequences of a female are therefore different than those of a male. It is important we understand how shift work can affect us independently of our male co-workers.

There is still a great deal of need for researching the specific health effects on women and shift work. From the studies that have been conducted, there is some evidence to suggest that women have greater difficulty adjusting to the demands of shift work and fatigue compared to males (Marquie & Foret, 1999). It has also been suggested that female shift workers have potential greater risk for gender related ill-health effects. Disturbances to the menstrual cycle (eg. Costa, 2003; Clayton, 2008), fertility and reproductive cycles (eg., Barzilai-Pesach, Sheiner, Potashnik, and Shoham-Vardi, 2006), and alarmingly, an increased risk for breast cancer (eg., Medgal, Kroenke, Laden, Pukkala, and Schernhammer, 2005; Stevens, 2009) have been reported. This study will seek to better understand the relationship between shift work and ill-health effects that may result in female shift workers when compared to non-shift working females.

2.1. Shift Work and Ill-Health Effects

There has been an expansive amount of research conducted on the ill effects of shift work and at night work when the body would typically be sleeping (Barton, 1994). Research literature has had a tendency to fall into three main areas of study: the disturbances in our sleep/wake or circadian cycles (eg., Akerstedt, 1990; DeKonick, 1997; Reinberg & Ashkenazi, 2008), the physical ill-health effects on our bodies (eg. Barton, L. 1994; Costa, 2003; Amelsvoort, Shouten, and Kok, 1999; Lin, Hsiao, and Chen, 2009), and the social and family disturbances that can be a result of working shift work (eg., Culpepper, 2010). Table 1 is a summary of the cited ill-health and shift work related research studies.

The most common problems reported by shift workers are disturbed sleep and wake time sleepiness (Dean et al., 2007). According to Dean et al., 2007, this reporting comes with no surprise as shift work and working at night forces the natural physiology of the body to work when it feels it should be sleeping. Demanding the body to work when it feels it should be asleep, and trying to make the body sleep when it feels it should naturally be awake, can have long-term health consequences. If the cycle continues of depriving the body of sleep, then forcing it to sleep when it feels it should not, sleepiness and fatigue can accumulate to dangerous levels (Dean et al., 2007).

The reason for this reported sleepiness and fatigue has been attributed to the nature of the circadian rhythm of our bodies. This rhythm is a 24-hour process that regulates cycles within our bodies such as body temperature, sleep/wake cycle, and hormone secretion (Stevens, 2009). According to Sherry of the Intermodal Transportation Institute at the University of Denver, our sleep pattern seems to be related to our circadian rhythm. Consequently, when we disturb our sleep cycle we also disturb our circadian rhythm and vice versa. Shift work, especially at night, can lead to a disruption of both cycles and therefore lead to increased fatigue levels. Sleep deprivation is additive, meaning that a lack of appropriate sleep accumulates overtime and can eventually add to sleep debt. Sherry has found that on average, shift workers slept 2 hours less per night when compared to non-shift workers, making shift workers more prone to developing sleep debt (Sherry, 2005). According to the Department of Family Medicine at Boston University Medical Center, when sleep debt accumulates past a certain level, an individual can actually be diagnosed with Shift-Work Disorder (SWD). SWD is diagnosed by the presence of excessive sleepiness (ES) and/or insomnia lasting a month or longer during which the individual is performing shift work (Culpepper, 2010).

Effects of fatigue can be seen be seen in many forms. Loss of alertness, impaired judgment, impaired mood, slower reaction time, increased errors, increased risk-taking, and reduced motivation are a few examples. Fatigue may also lead to mood changes in the form of irritability and negativity (Sherry, 2005). According to Chung et. al., “sleepiness, fatigue, and sleep deprivation negatively affect functioning, resulting in decreased productivity, increased errors and workplace accidents, traffic collisions, and deterioration of relationships, and may trigger a general decline in health and well-being”. Fatigue within the transportation industry is particularly challenging due to the fact that the industry operates on a twenty-four hour, seven day a week demand. Accidents on the job within the transportation industry can have detrimental and fatal effects. The issue of fatigue in transportation workers has been a top priority of the National Transportation Safety’s Board (NTSB) for the past 2 decades (Sherry, Belenky, and Folkard, 2006). In 2002, the Transportation Research Board released a report that found 20 percent of responding transit agencies to a survey conducted by the American Public Transportation Association identified fatigue as a contributing factor to job-related accidents (TCRP, Report 81).

Additional issues as a result of accumulated disturbance in sleep may be seen in the form of physical and psychological health conditions. Although further research is needed, increased risk for cardiovascular complications (eg. Ellingsen, Bener, and Gehani, 2007), higher instances of obesity and gastrointestinal disturbances (eg. Van Amerlsvoot, Schouten, & Kok, 1999), mental health disturbances including higher instances of depression (McClung, 2011) and social interferences (eg. Culpepper, 2010) have been documented. Gender specific risks for females that will be further discussed have additionally included potential changes in menstruation cycles (eg. Costa, 2003), fertility disturbances (eg., Barzilai-Pesach, Sheiner, Potashnik, and Shoham-Vardi, 2006), and a possible increased risk for developing breast cancer (eg. Medgal, Kroenke, Laden, Pukkala, and Schernhammer, 2005).

Shift workers have a moderately higher incidence of cardiovascular disease when compared to non-shift workers (Shapiro et. al, 1997). It is still unclear why this is so but has been equated to the natural circadian rhythm of our body and how it controls our heart rate and blood pressure rates throughout the day (Culpepper, 2010). It is also possible that the stress and strain placed on shift workers bodies and personal lives makes them more susceptible to cardiovascular disease. Even when these factors are taken into account though, an increase rate of heart disease still exists among shift workers. The dangers of heart trouble seem to increase with the duration of years of working shift work (Shapiro et al, 1997). In 2008, a study was released by the Department of Internal Medicine at the Taiwan National University Hospital that monitored shift workers for 48 hours. The study monitored individuals after working a 12 hour night shift, followed by a 36 hour recovery period. The electrocardiogram that was used reported elevated blood pressure, decreased heart rate variability, and incomplete blood pressure recovery within the 36 hour recovery time period (Su, Lin, Baker, Schnall, Chen, Hwuang, and Wang, 2008). They reasoned that persistent activity during the night reduces, or eliminates entirely, normal decreases in blood pressure that would naturally happen in the body overnight. They also concluded that heart rate variability is a cycle that is controlled by circadian rhythms during sleep cycles. The study concluded that individuals that do not experience natural circadian controlled fluctuations in blood pressure and heart rate are possibly more likely to develop cardiovascular complications (Culpepper, 2010). An increased risk for cardiovascular disease is being associated with shift-work, reported as high as 40% compared to non-shift workers (Boggild & Knutsson, 1999).

The relationship between sleep disturbance and obesity is well documented but poorly understood, in part because of the complexity of the correlation (Culpepper, 2010). It has been found that there is evidence to suggest that shift workers have lower fitness levels than day workers. It has also been suggested in research that being fit appears to increase tolerance to shift work (Popkin, Howarth, and Tepas, 2006) In 1999, the International Journal of Obesity and the Division of Human Nutrition and Epidemiology at Wageningen Agricultural University in the Netherlands published a study to understand the relationship between duration of shift work and the physical factors that can lead to obesity. Body mass index (BMI) and waist to hip ratio (WHR) were measured among 377 shift workers and non-shift working controls. They understood that an elevated risk for obesity in shift workers had increasingly been reported in research, but that the mechanisms for this increased risk were still unclear. They wanted to investigate the relationship between BMI as a possible explanation for changed eating habits and altering metabolic involvement as duration of shift work increased (Van Amelsvoort, Schouten, and Kok, 1999).

A positive relationship was found between BMI and WHR when duration of shift work increased. BMI was calculated by weight and height with a descriptive ratio between waist and hip circumferences. Obesity was defined as having a BMI greater than or equal to

25kg/m2. Of those women who never performed shift work, a BMI mean was observed at 23/kgm2. Women who had worked up to 2 years of shift work had a slight increase BMI mean of 24.1, while women working 5 years of shift work had a mean BMI of 24.3. The relationship between BMI and duration of shift work was found to significantly correlate (Van Amelsvoort, Schouten, and Kok, 1999). Their conclusions were that WHR and body weight or BMI could be a mediating factor between shift work, obesity, and cardiovascular risk. More research is needed in order to understand other factors in this conclusion, such as time permits for exercise and nutrition while working shift work.

A study conducted in 2011 by researchers at Brigham and Women's Hospital also looked at the relationship between depriving our body and disturbing our natural circadian rhythms with an increased risk for obesity and diabetes. Participants consisted of 21 healthy individuals within a controlled environment for nearly six weeks. The amount of sleep was controlled for each participant by the researchers starting with a full night of rest, followed by a period of sleep deprivation to simulate a variable shift work schedule. Prolonged disturbances to sleep allowance and therefore disturbances to circadian rhythms resulted in a decreased metabolic rate as well as increased glucose concentrations in the blood. A decreased metabolic rate is theorized to result in a yearly 10 pound or more for an individual while glucose concentration can certainly contribute to an increase to risk for diabetes (Buxton, Cain, O'Connor, Porter, Duffy, Wang, Czeiselr, and Shea, 2012).

Compared with their day-time counterparts, shift and night workers have been reported to have an increased risk for gastrointestinal problems such as constipation and diarrhea, as well as longer term gastro-intestinal disorders and peptic ulcer diseases (Shapiro et al., 1997). Research is again linked to disturbances in our sleep patterns in that gastric secretions in the middle of the night caused by eating will interfere in the natural enzymatic activity of our bodies and digestive systems (Culpepper, 2010). Our bodies will additionally release certain enzymes and stomach acids when it feels it should be eating and is not. If work schedules or sleeping patterns do not allow you to eat when your body feels it should, the released acids can cause heartburn and more serious gastrointestinal problems down the road (Shapiro et al, 1997). It is important to think about the possibility that shift work at night may lead an individual to eating meals at abnormal times and/or eating more than one normally would throughout a 24 hour period. There may be limited types of available meals one can choose from while working at night, especially healthy options. If time did not permit a prepared meal, fast food is likely an easy reach. There is also the possibility that a shift worker battling sleep debt will increase their intake of tobacco, alcohol, and especially caffeine to try to cope with wake-time sleepiness and fatigue on the job. The increase of using these substances may be contributing factors to all health related issues including cardiovascular risk, obesity, and gastrointestinal disturbances (Peate, 2007).

Although there is much further need to explore the social and domestic disturbances that can be equated with working shift work, particularly how differences of these disturbances are experienced separated by gender, some research has indicated a negative effect on social and home life for all shift workers. Even though roughly a quarter of the American workforce works shift work, our society is still structured for the day worker. It can be difficult for the shift worker to balance finding time to be with partners, children, and friends (Shapiro et al., 1997).

The Henry Ford Hospital of Sleep Disorders and Research Center released a study in 2004 that looked at absenteeism within social connections and families of 2,570 individuals aged 18 to 65 in the Detroit vicinity. 360 of those individuals were working rotating night shifts, 174 worked permanent night shifts, and the remainder of participants were day workers. Type of shift was determined via self-report of participants. Participants were asked to choose the category that best described their schedule in the last 2 weeks from the following categories: regular day shifts, regular night shifts, regular evening shifts, rotating shifts, or not working/retired. Results found that regular night workers fighting excessive insomnia and sleepiness missed 8.6 days of family or social activity per month compared to their counterpart day worker who missed 1.5. Rotating shift workers with excessive fatigue and sleep debt missed even more days per month, 10.1, of family and social activity (Drake, Roehrs, Richardson, Walsh, and Roth, 2004). Limits of this study include the lack of gender discussion and analysis as well as intentional non-inclusion of those individuals working night shifts. It should be noted that shift work does work for some individuals schedules' and families. There is no doubt that shift work can be accepted by spouses and systems of support. The importance and support of family, friends, co-workers, and supervisors has proved to enhance adaptability and tolerance to shift work (Costa, 2003).

Some research has indicated a higher risk for mental health disturbances including depression when working shift work. It has been well documented that affective disorders are theorized to be related in some way to the bodies' circadian rhythm (Emens, Lewy, Kinzie, Arntz, and Rough, 2009). McClung, 2011, in her review of the relationship between circadian rhythms and mood regulation asserts that mental disturbances such as major depression, bipolar disorder, and seasonal affective disorders are highly correlated with disruptions to the bodies' natural circadian rhythm. McClung describes how, similar to season change leading to seasonal affective disorder, working shift work can actually lead to profound mood related changes based on disturbances to natural sleep wake cycles and ultimately the bodies natural circadian rhythm. She claims that, "there is a high incidence of major depressive disorder observed during and after shift work experience with increased risk associated with duration of exposure" (McClung, 2011, p. 4). McClung theorizes that the circadian rhythm is controlled internally yet the environment on which it is influenced by can have profound effects on the way in which it operates. If the environment therefore poses stress, lack of light, or irregularity to sleep for example, the rhythm will be impacted. Limitations to these generalizations are that the majority of studies that have pointed to the circadian rhythm as a modifier of mood related behavior come from the use of animals models.

In 2007, Sookoian, Gemma, Gianotti, Burgueno, Alvarez, Gonzaolez, and Pirola, of Buenos Aires University sought to understand the relationship between working shift work, the natural circadian rhythm of the body, and the mental health consequences that can result. 683 mean were included in the study; 437 were day workers and 246 were rotating shift workers with irregular schedules. The participants' schedules were divided into rotating shift work and daytime work. Rotating shift work was characterized by a 2-shift and clockwise rotation over the course of one month defined as 28 days. Rotating shift was 4 work days, 3 rest days, 2 work nights, 3 rest days, 4 work nights and 3 rest days, 2 work days, 3 rest days, 4 work days. Day and night work were defined by shifts starting at 6:00AM or 6:00PM respectively. The day or shift work duration was defined as the total number of months during which the subject had engaged in day work or shift work. The researchers interestingly measured levels of serotonin via blood sample content of each of the groups knowing that serotonin is one of the first neurotransmitters to be associated with the regulation of the bodies' circadian rhythm. Results revealed that serotonin content differed greatly between day workers and rotating shift workers with levels of serotonin significantly higher in those individuals working day work leading the researchers to believe a potential explanation for higher instances of depression in night workers (Sookoian, Gemma, Gianotti, Burgueno, Alvarez, Gonzaolez, and Pirola, 2007).

In 2007, Scott, Monk, Luann, and Brink sought to understand the relationship between shiftwork and Major Depressive Disorder (MDD). Random telephone survey's were conducted with 98 past and current shift workers; 31 women were including in the study. Results yielded a significant higher prevalence of MDD with either current or previous shift work experience. Results also yielded a correlation between increased exposure, specifically 20 years or more of working shift work, with an increased risk for MDD. The authors utilized a structural equation model to illustrate two theories to explain their findings. The model held that the findings were a result of "shiftwork coping" ability in an individual and the hardships he or she would have to endure (i.e. changes to sleep, social/domestic cycles, and the circadian rhythm). They theorizes that these factors and limited ability to cope with them can lead to stress thereby increasing the likelihood of depressive symptoms. The second component of the model described how the interruption to the individual's life events from working shift work leads to a continuation of depression and continued maladaption of the bodies' natural rhythms (Scott et al., 1997).

Results from the *Sleep in America Poll* (Johnson, et al, 2014) of transportation workers found that many respondents reported difficulty in mood following their work shifts. Approximately 85.25% of transportation worked indicated that their mood was impacted by their shift work.

Although there are a number of studies indicating a correlation between working shift work and ill-health effects that can result, there are a number of limitations to previous research that the current study will seek to address. Studies that seek to identify generally ill-related health effects from working shift work often fail to incorporate gender analysis in their methodology. If gender analysis was included (i.e. Marquie & Foret, 1999), additional factors such as social responsibility as well as biological differences in genders were not included in the analysis. Known differences of risk for listed ill-health effects such as diabetes, cardiovascular disease, and sleep disorders are poorly distinguished between genders. Limitations of previous research also include failing to distinguish risk associated with type of shift worked. As discussed, shift work can come in a variety of forms with a multitude of varying shifts (i.e. night versus day, fast versus slow rotation, length of shift etc.)

Although there have been some studies that have sought to differentiate between type of shift work, Sookoian, Gemma, Gianotti, Burgueno, Alvarez, Gonzaolez, and Pirola, 2007, for example, most studies do not account for differences between ill-related health risk outcome and quantity of shift work endured.

Table 1. Shift work and health effects.

Author	Year	Sample/Participants Studied	Measures	Results
Marquie & Foret	1999	2,767 active and retired shift and non-shift workers, age 32-62	Questionnaire, response rate 76%	Women had poorer sleep and when compared to men were more likely to have difficulty staying asleep, twice as many women reported using medications to help them sleep.
Transit Cooperative Research Program, (TCRP) Report 81	2002	135 Transit Agencies	American Public Transportation Association (APTA) survey	20% of responding agencies identified fatigue as a contributing factor to on-road accidents; most agencies did not consider fatigue in their accident and injury investigations
Su, Lin, Baker, Schnall, Chen, Hwuang, Wang	2008	15 male shift workers	Monitored by a Holter electrocardiogram for 48 hours, after completing a 12 hour shift with a 36 hour recovery period	An elevation in blood pressure, decreased heart rate variability, and incomplete blood pressure recovery in recovery period
Van Amelsvoort, Schouten, & Kok	1999	377 shift workers and non-shift working controls	Questionnaires were used to collect past work history. In-person medical exams by research nurses were used to monitor BMI,	A positive relationship between BMI and WHR with shift work duration was observed in both males and females

			WHR, and cardiovascular risk changes over an 18 month period	
Buxton, Cain, O'Connor, Porter, Duffy, Wang, Czeislr, & Shea	2012	21 healthy individuals	Participants were placed in a controlled environment for 6 weeks. Sleep stimulation was imposed to create sleep deprivation enactment	Prolonged disturbances to sleep resulted in a decreased metabolic rate as well as increased glucose concentrations in the blood
Sookoian, Gemma, Gianotti, Burgueno, Alvarez, Gonzaolez, & Pirola,	2007	683 men; 437 day workers and 246 rotating shift workers	Levels of serotonin were measured via blood sample	Serotonin content for day workers was significantly higher than those working consistent night shifts
Scott, Monk, Luann, Brink	2007	98 past and current shift workers	Random telephone survey's were administered	Significantly higher percentages of Major Depressive Disorder (MDD) with either current or past shift work experience. 20 years or more of shift work led to an increased risk of MDD.
Drake, Roehrs, Richardson, Walsh, Roth	2004	2,570 individuals aged 18 to 65 . 360 rotating night shifts workers, 174 permanent night shifts workers.		Permanent night workers missed 8.6 days of family or social activity per month compared to their counterpart day worker who missed 1.5. Rotating shift workers with excessive fatigue and sleep debt missed even more days per month, 10.1, of family and social activity

2.2. Women and Shift Work

Women make up roughly half of the American work force (Chung et al., 2009). The female work force deserves particular attention when occupational demands lead women to working at night and shift work schedules. The physiology of the female body is obviously different than that of a male. Female family role and responsibilities as well as reproductive ability bring different challenges when females are faced with sleep deprivation. The health consequences of a female are therefore different than those of a male. It is important to understand how shift work can affect women independently of the male co-worker. A summary of cited female related studies to shift work is listed in Table 2.

There is still a great deal of need for researching the specific health effects on women and shift work. From the studies that have been conducted, there is some evidence to suggest that women have greater difficulty adjusting to the demands of shift work and fatigue compared to males. In a questionnaire study in which 2,767 active and retired shift workers were questioned, results found that women, when compared to men, had significantly more difficult problems falling asleep, staying awake, and falling back asleep if they were woken up. It was also found that twice as many women reported using medications to help them fall and stay asleep. In one sense, this is attributed to the possibility that females biologically experience the effects of sleep problems more harshly. Both genders who have had worked shift work at some point of their lifetime were found to have problems with falling and staying asleep when compared to their non-shift working counterparts. (Marquie & Foret, 1999). The study however failed to include a detailed work schedule within their methodology for both genders. Those participants who had worked shift work in the past were asked to state whether their job included irregular hours, “activity” that prevented sleep before midnight, or “activity” resulting from awakening before 5AM, yet detailed shift work schedules (i.e. night versus day work) were not accounted for.

Shapiro et al., 1997, report that nine percent of women chose to work shift work as a result of helping meet child care needs, compared to men who did not even give that as a reason. Another explanation therefore, which needs further attention, may be that females actually sleep less because of social factors and responsibilities such as motherhood and household dependencies. For families with children younger than six, four out of ten married women were reported to work shifts in order to provide better child care (Shapiro et al., 1997). In 2007, a study was conducted to understand the experience of women specifically working within the transportation system. Focus groups were conducted to ask questions on things such as promotion, harassment at the workplace, and managing childcare responsibilities while working demanding hours. Results found that many of the participants either chose not to enter the transportation field or left their job due to the hours not being convenient for taking care of a family. Many expressed the desire to spend more time with their children instead of working at night or on shift work hours that were demanded by the job (Pinarowicz and Lange, 2007).

It has been suggested that female shift workers have potential greater risk for gender related ill-health effects. Disturbances in the female menstrual cycle (eg. Costa, 2003; Clayton, 2008), fertility and reproductive cycles (eg., Barzilai-Pesach, Sheiner, Potashnik, and Shoham-Vardi, 2006), and alarmingly, an increased risk for breast cancer (eg., Medgal, Kroenke, Laden, Pukkala, and Schernhammer, 2005; Stevens, 2009) have been reported.

A number of studies have suggested that shift work can cause heavier or more painful menstrual cycles. In a questionnaire study of 801 female flight attendants that were less than 50 years of age with at least one pregnancy and not using oral contraception, 62% reported menstrual disturbances and disorders including pain, heavier bleeding, absence of period, intermenstrual bleeding, and lighter bleeding. Menstrual irregularities were found to be more frequent among current flight attendants than former (20.6% vs. 10.4%, $p = 0.02$) (Lauria, Ballard, Caldora, Mazzanti, and Verdecchia, 2006). Limitations to this study included an inability to compare outcome of menstrual disturbance among a variety of occupations. The only participants in the study were flight attendants indicated a potential risk of additional factors that were not able to be controlled for such as circadian rhythm disturbances and duration of shifts worked. The study was also a cross-sectional study indicating an inability to label the associations found to be causal.

It has also been found that lower rates of pregnancies and deliveries as well as preterm delivery and/or low birth weight may be a result of shift work (Costa, 2008). One study examined the possible association between women's occupational stress, defined by working hours and particularly shift work, and fertility treatment success. Results concluded that a higher workload, or longer hours and the presence of shift work, decreased the likelihood of conception after a fertility treatment. Actual workload of females was only measured by a self-reported indication by participants of working "part-time" versus "full-time". An in depth analysis of exact lengths and nature of shifts worked was not included in the researcher's methodology (Barzilai-Pesach, Sheiner, Potashnik, and Shoham-Vardi, 2006).

In 1987, Messing, Saurel-Cubizolles, Bourgine, and Kaminski administered medical examinations and questionnaires to 726 female shift workers in the poultry and cannerie factory business. Inclusion criteria for participants in this study were employment at the factory, not having gone through menopause, and not currently being pregnant. Work related conditions were evaluated using self-reported questionnaires that covered areas such as working hours, working week, and irregularity of working schedules. Participants were asked whether they began and ended their shifts at the same time as well as their earliest and latest hour of beginning or ending a shift. Women were only analyzed based on regular or irregular self-report of shift schedule. A medical questionnaire was also given with the help of a physician that included questions on menstrual cycles and contraception use. Women were noted as having previous irregular cycles if self-reported within the last year. Results were observed in the areas of menstrual irregularities and non-occupational characteristics and with occupational characteristics including schedule variability. It was found that overall irregular cycles, periods of amenorrhea, and longer menstrual cycles were associated with the most schedule variability of the workers. They concluded that, "regular predictable schedule variations do not seem to affect hormonal cycling in the same way as irregular schedules" (Messing et. al, 1992).

Labyak, Lava, Turek, and Zee, 2002, evaluated menstrual function, fertility, and pregnancy outcomes in 68 shift working females nurses. They theorized that women experience greater difficulty adjusting to shift work and therefore are at greater risk for developing ill-health related affects including menstrual disturbances. "Women displaying this shift work intolerance may be at greater risk for changes in menstrual functions, infertility, and adverse pregnancy outcomes; however, this has not been evaluated" (Labyak, et al., 2002, p. 705). Inclusion criteria were female nurses who reported normal menstrual cycles for the majority of their lives, had no diagnosed menstrual dysfunction, had not gone through menopause, and had not undergone surgery that would have affected their menstruation. 68 nurses aged 22 to 39 were surveyed with average length of shift work being 3.3 years. Shiftwork was defined as working either the evening shift (3:30PM to 12:00AM) or the night shift (12:00AM to 8:00AM). Participants were asked to complete the Nursing Shiftwork Questionnaire that included reproductive and menstruation health as well as sleep history. A significant 53% of respondents reported changes in their menstrual function when working shiftwork. It was also found that women endorsing menstrual changes when working shift work reported significantly longer sleep latencies while working at night versus those women who did not endorse menstrual changes. Women who experienced menstrual changes also reported significantly higher rate of sleep disturbance. "Changes in menstrual cycle function and a higher incidence of painful menstruation occur among many female nurses working nights and rotating shifts" (Labyak et al., 2002, p. 709). When compared to reported normal populations, only 20 percent of women in their reproductive years report irregular menstrual cycles (Labyak et al., 2002). The study failed to incorporate a distinction between specific hours worked and length of working shift work. The study is also limited in the lack of occupational variety as all participants were nurses. The researchers were also met with the reality that a shift work survey for females did not exist during the course of their data collection. The researchers therefore created their own measure that lacked validity and reliability.

One possible explanation for reproductive disturbances in female shift workers ties back into interruptions in sleep patterns, and consequently interruptions to the natural circadian rhythm. “This may be the result of gender differences in disturbances to the circadian sleep/wake rhythm, including a decline in sleep length, increased fragmentation of sleep, and increased sleepiness and fatigue during their shift” (Labyak et al., 2002, p. 704). A survey conducted in 1993 of 2,988 United States shift workers revealed significant shorter sleep periods for women aged 18 to 49 when compared to their male counterparts (Tepas, Duchon, and Gersten, 1993). Particularly, these reproductive disturbances may be the result of the interference of specific hormonal production within the female circadian rhythm. Hormone production regulated by circadian rhythm can include: prolactin, melatonin, thyroid-stimulating hormone (TSH), and lutenizing hormone (LH), all of which are linked to reproductive health disturbances (Chung et al., 2003). An additional explanation of some authors is that the observed reduced frequency of pregnancies in women working shift work may also be due to females facing additional difficulties in family and social life due to irregular and unaccommodating work schedules (Uehata and Sasakawa, 1982).

In 2005, a meta-analysis of 13 research studies was conducted to examine the ill-health effects on women and shift work. Of those 13 studies, 7 of them included airline cabin crew members. Although there is much more need for research, collectively the studies indicated an increased risk of breast cancer among the participants. The analysis conducted a systematic review of MEDLINE articles from the 1960's until January of 2005. Eligible studies were only accepted if they included observational research that studied any type of shift work and breast cancer risk. No restriction was placed on origin of race of the women, but studies were excluded if they did not separate male from female. Night shift work was defined as any shift schedule including overnight work, while airline crew criteria was met if an individual worked international or long-distance flight service that involved circadian rhythm disturbances, exposure to artificial light at night, and experiences of jet lag (Medgal, Kroenke, Laden, Pukkala, and Schernhammer, 2005).

Results of the meta-analysis of these studies concluded that women working these shifts had a greater risk of breast cancer. In pooled results, a significant 48% increase in the risk of breast cancer was found among female shift workers! (Medgal et al., 2005). The combined Standard Incidence Ratio (SIR), or the ratio of the observed to the expected new cases of cancer, was 1.48 for all 13 studies. The largest study within the analysis took place in the United States. It observed a group of 44,021 female members of the Association of Flight Attendants in California. Of these cases, 129 incidents of breast cancer occurred between 1988 and 1995. It held the highest individual study SIR of 1.42 among all studies observed (Reynolds, Cone, and Layefsky, 2002).

The hypothesized explanation for finding this link between working at night and an increased risk for breast cancer is that artificial light exposure may disrupt reproductive hormone levels in women, as well as negatively affecting normal melatonin production levels. Experimental lab studies support the findings that melatonin in the body suppresses tumor cells, including in the breasts. (Megdal, et al., 2005). Natural production of melatonin in the body happens at night. Peak hour for melatonin production has been documented at 1AM. When a female night shift worker is exposed to artificial light, when melatonin production is at its natural peak, production levels of melatonin are significantly reduced. The decreased availability of naturally produced melatonin in the body is being attributed to the body being less capable of counteracting the growth of malignant cells of the breast (Megdal, et al., 2005).

The increased risk for breast cancer is also being linked to disturbances in sleep patterns and to natural circadian rhythms. In 2001 The Fred Hutchinson Cancer Research Center in Seattle conducted a study to compare the sleeping patterns of 800 Seattle-area women who were recently diagnosed with breast cancer to an equal amount of healthy women. It was found that the women who were diagnosed with breast cancer were more likely to report sleep disturbances than women who were not diagnosed. Exposure to light at night may increase the risk of breast cancer by suppressing the normal nocturnal production of melatonin by the pineal gland, which, in turn, could increase the release of estrogen by the ovaries. This study investigated whether such exposure is associated with an increased risk of breast cancer in women. An in-person interview was used to gather information on sleep habits and bedroom lighting environment in the 10 years before diagnosis and lifetime occupational history. “Graveyard shiftwork”, defined as beginning work after 7PM and leaving before 9AM, was associated with increased breast cancer risk (OR = 1.6; 95% CI = 1.0 to 2.5), with a relationship between increased risk and increasing years as well as with more hours per week of graveyard shiftwork. It was also concluded that among the women studied, women who were averaging 5.7 hours or more of “graveyard shift” per week faced double the incidence rate of developing breast cancer compared to those women who did not work at night (Davis, Mirick, and Stevens, 2001).

In 2001, Schernhammer, Laden, Speizer, Willett, Hunter, Kawachi, and Colditz examined the relationship between breast cancer and working rotating night shifts as a shift worker. Their subjects consisted of 78,562 nurses take from the Nurses’ Health Survey study conducted in 1998. Of all participants, they observed 2,441 incidences of breast cancer. Logistic regression models were used to calculate relative risks associated for breast cancer incidents. The authors observed a significant moderate increase in breast cancer risk for those women who worked rotating night shifts at some point of their shift-working career. The authors found additional significant risk for those women who worked rotating night shifts, defined as at least 3 nights per month in addition to afternoon and evening shifts in that month, for more than 30 years. Although the study took into account type of shift (i.e. night rotations), specific length of time working nights was not differentiated. The study is also limited to the nursing profession.

In 2005, a study was conducted by the International Agency for Research on Cancer that experimentally discovered that melatonin-depleted blood from pre-menopausal women who were exposed to artificial light at night stimulated the growth of human breast cancer cells in lab rats. The study led the International Agency for Research on Cancer to conclude, “Shift work that involves circadian disruption is probably carcinogenic to humans”. (Stevens, 2005, p. 107). There is a need to further explore the link between exposure to artificial light on night shifts, melatonin suppression, and increased breast cancer risks in women to make valid and consistent conclusions.

Although there has been an extensive amount of research conducted on the ill-related health effects that can result from females working shift work, more analysis is needed. Although some studies have done a fair job at analyzing the multi-faceted phenomenon of female health and shift work, the majority of studies that have been conducted fail to account for a number of variables including detailed analysis of the vast types of shifts that females can work, length of time working shift work, and external factors including psycho-social variables.

Table 2. Female Gender and Shift Work Research Studies

Author	Year	Sample/Participants Studied	Measures	Results
Marquie, J & Foret, J.	1999	2,767 active and retired shift and non-shift workers, age 32-62	Questionnaire, response rate 76%	Women had poorer sleep and when compared to men were more likely to have difficulty staying asleep, twice as many women reported using medications to help them sleep.
Messing, Saurel-Cubizolles, Bourgine, & Kaminski	1987	726 active female shift workers in poultry and cannerie factories	Demographic questionnaire as well as medical history questionnaire	Menstrual irregularities including longer menstrual cycles, amenorrhea, and irregular cycles were significantly related to high variability in scheduling
Lauria, Ballard, Caldora, Mazzanti, Verdecchia	2006	801 flight attendants, less than 50 years of age, at least 1 pregnancy, not using oral contraception	Questionnaire study	62% reported menstrual disorders while working as a flight attendant
Labyak, Lava, Turek, Zee	2002	68 female nurses working shift work	Nursing Shift Questionnaire	A significant 53% of respondents reported changes in their menstrual function when working shift work
Barzilai-Pesach, Sheiner, Potashnik, Shoham-Vardi	2006	75 working women with fertility problems that led to attending a fertility clinic	Questionnaire study to measure job strain and workload	An inverse association was found between higher workload and conceiving. The likelihood to deliver after fertility treatment was associated with less working hours.
Medgal, Kroenke, Laden, Pukkala, & Schernhammer	2005	7 studies meeting inclusion criteria were of flight attendants, 6 were other forms of night work. The largest study in the United	Separate and combined meta-analysis for female airline cabin crew and	An increased risk for breast cancer was found among women working shift and night

		States: 44,021 female members of the Association of Flight Attendants in California.	female night shift workers	work. The combined Standard Incidence Ration (SIR), or the ratio of the observed to the expected new cases of cancer, was 1.48 for all 13 studies
Schernhammer, Laden, Speizer, Willett, Hunter, Kawachi, and Colditz	2001	78,562 registered nurses	Nurses completed a one time self report on shift; biannual follow-up from 1989-2001	The authors observed a significant moderate increase in breast cancer risk for those women who worked rotating night shifts at some point of their shift-working career
Davis, Mirick, Stevens	2001	1,600 women, half who were recently diagnosed with breast cancer	Questionnaire designed to understand sleep disturbances	Women averaging 5.7 hours or more of night shift work per week faced double the incidence rate of breast cancer compared to those women who did not work at night

2.3. Transportation Hours of Service

It is important to note that shift work schedules can look vastly different between various jobs and that the way a schedule is structured has a varying effect on ill-health results. Shift work schedules often periodically change, adding to the circumstances under which the body will have time to recover. Workload can vary between shifts, as well as periods of rest or days off in between. Variance of workload and shift schedule can depend on the work sector and/or particular company (Costa, 2003). Knowing the amount of time available for the body to recover after shift and night work is important in understanding the risk associated with working shift work. It has been recommended that the number of shifts worked at night should be as few as possible. The accumulated effects of more than three night shifts in a row has proven to be a great strain and can seriously contribute to sleep debt.

Rapid rotation of night shifts and starting a sequence of shifts with a night shift has been reported to provide more room to recover (Akerstedt, 1996). It has been recommended that each sequence of night shifts should be followed by 48 hours of recovery at the minimum before returning to working during the day. The first 24 hours following a night shift are of “low-quality”, the second day can be viewed as adequate recovery but many individuals may need even more time (Akerstedt, 1996).

Direction of rotation of shifts has also proven to have an effect on the way in which our bodies recover and are able to return to normal rhythms. It is reported that the bodies’ natural sleep-waking cycle that coincides with the bodies circadian rhythm are more easily delayed than they are advanced. This indicates that a clockwise rotation of morning-afternoon-night sequence would allow for more natural recovery and rhythm function than a counterclockwise shift schedule. Morning shifts following a night shift should be avoided entirely to prevent severe disturbances to sleep cycles (Akerstedt, 1996). The amount of time the body has to recover between shifts has also indicated a change in the way the body will recover. A minimum of 11 hours of actual rest time, which equates to about 16 hours between shifts, has been reported as ideal for the body to return to its natural sleep/wake cycle. Shifts exceeding 8 hours are discouraged, but if unavoidable it is important for the body to work a short sequence of longer shifts. For example, working two 12-hour shifts should be followed by two full days off (Akerstedt, 1996).

A number of research studies have indicated that shift work negatively affects an individual’s health and wellbeing (Costa, 2003; Medgal, et al., 2005; Clayton, 2008). Shift schedules can look vastly different among industries. Shifts schedules often rotate and do not remain constant for shift workers. It has been indicated (Akerstedt, 1996) that at night work and high variability of shift schedule can lead to increased risk for ill-heath effects described above. Ill-related health effects are theorized to be caused by disturbances to physiological, psychological, and psychosocial circadian rhythms (Bambra, Whitehead, Sowden, Akers, and Petticrew, 2008). The greatest disturbances to these rhythms come from working night shift work or on a highly rotating or variable schedule leading to increased problems with regular sleep. It has been found that workers on rotating shifts have higher incidences of injury than workers on fixed shifts (Bambra et al., 2008).

It is well documented that working shift work between the hours of midnight and 6AM or shifts starting during the night hours, as defined by Sallinen & Kecklund, 2010 as between 4AM and 7AM, are highly associated with disturbances to the sleep-wake cycle (Sallinen & Kecklund, 2010). The rate of sleepiness has been documented at roughly 50% in the night shift compared to 5% in the day shift that is often reasoned to the body naturally aligning with the circadian rhythm better during the day (Sallinen & Kecklund, 2010). Sallinen & Kecklund, 2010 conducted a literature review of studies conducted on the various scheduling of shift workers and how each variety of shift schedules can affect sleepiness and fatigue. Findings from 3-shift systems, irregular 3-shift systems, 2-shift systems, permanent night work, and shift systems with extended hours of operations were examined. The researchers generally found that night and early-morning shifts as well as fast rotation of shifts are the most associated with shorter sleep periods and an increase to sleepiness as well as a disturbance to natural sleep-wake patterns.

For example, one study conducted in 1992 by Tilley, Wilkinson, Sowden, Akers, and Petticrew showed a 1.5 hour higher average of length of sleep for a daytime worker when compared to shift workers completing night work. Another study reported higher instances of napping, falling asleep, and increase risk of workplace related accidents when working night work compared to day workers (Cruz, Rocco, and Hackworth, 2000). In Sallinen and Kecklund's, 2010, review of research studies that looked at shift work schedules, results also indicated that night and early morning shifts as well as fast rotations were associated with higher rates of sleepiness. Recommendations from this study include switching from a slow to fast rotation and decreasing the number of night shifts worked. Critically to understand, the researchers found a significant shortage of controlled intervention studies that have been conducted to date. Particularly, the researchers did not find any studies that analyzed interventions for irregular shift work or permanent night work indicating a lack in the literature of quantifying these shifts particularly. An additional limitation in the research studies cited was a lack of analysis of different shift systems and potential outcomes that may result. The review indicates an overarching need for more shift system specific research.

Kostreva, McNelis, and Clemens, 2002 reviewed circadian rhythm models previously created to evaluate shift schedules and best practices based within a mathematical setting. The authors utilize the two-oscillator model of free-run human circadian rhythms that was developed by Kronauer in 1982 to mathematically represent the circadian rhythms of a shift worker from a variety of schedules. Mathematically simulations of circadian rhythms were generated based on these models to compare the efficiency and changes to circadian rhythms of a variety of schedules. Numerical results of the analysis supported that the best shift schedules with the least natural disturbance to the circadian rhythm were slow rotations in a forward direction, remaining on a certain shift for a 2 week period before moving onto a different shift, and a rest period of 2 days off per week. “Disruption of the circadian rhythm can also lead to disharmony within the body... This leads to desynchronization, which itself can result in psychological malaise, fatigue, and gastrointestinal problems. Realignment can take several weeks (Bambra et al., 2008)”

According to a study conducted by Fido and Ghali, 2008, a sample of 200 males were determined to have higher incidences of health related ill-health effects from working variable shift work when compared to those individuals working a steady eight hour daytime shift. Participants were described as shift workers if they did not work a fixed daytime shift.

Fido and Ghali, 2008 found significantly higher rates of smoking, caffeine consumption, gastrointestinal complications, stress, and poor sexual performance for those working shift work at night versus those working consistently during the day. The shift workers were also found to have higher rates of fatigue that lead to more incidences of accidents and errors at work. Additionally, shift workers were found to have higher levels of depression and distress. Fido and Ghali, 2008, concluded that an 8-hour variable shift schedules experienced significantly greater health problems, poor quality of sleep, and an increase to workplace accidents when compared to those workers on a straight daytime shift schedule. Although results were significant, the authors failed to incorporate a detailed analysis of shift system into their methodology. Participants were categorized as working either a straight daytime shift schedule or not; no comparison or analysis was made within the irregular shift workers.

In 2008 Choobineh, Soltanzadeh, Tabatabee, Jahangiri, Neghab, and Khavaji conducted a study with 549 shift workers to compare psychosocial problems among a variety of shift schedules within the Iranian petrochemical industries. The cross-sectional study was conducted over eight factories within the Asalooyeh, Iran area. All information was collected via self-report in anonymous questionnaire. The researchers looked at three types of schedules, 4 nights-7 days-3 nights – 7 rest, 7 nights – 7 days – 7 rest, and 7 days – 7 nights – 7 rest. The workers were found to have higher incidences of psychological disturbances including irritability, nervousness, and decreased decision-making among the 7 – day - 7 night – 7 rest rotation (Choobiney et al., 2008).

Bambra et al., 2008 conducted a systematic review of all experimental and quasi-experimental studies. Inclusion criteria were studies that analyzed interventions to reduce the effects on health and shift workers. The researchers looked at studies that examined the effects of speed of rotation of shift, direction of rotation, removing shift work rotation all together, changes to night work, later start and finish times, weekend work, decreased shift length, and self-scheduling. None of these listed interventions were found to have negative effects on the shift workers. However, the three interventions that were found to have significantly positive effects on reducing ill-health effects on shift workers were: a fast rotation of shifts worked; a forward rotation of shifts; and the ability of shift workers to self-schedule themselves. Limitations to this study include only 26 intervention studies being included with the majority conducted on all men. The “changes to night work” did not compare night versus day work, only changes to night schedules, which still included shift work at night.

2.4. Hours of Service and Women

Davis, Mirick, Chen, and Stanczyk, 2012, theorized that women working at night may have an increased risk for breast cancer when compared to their daytime workers. The researchers believes that the increased risk for breast cancer came from a disturbance to the natural release of melatonin in the body that was sparked at night causing an increase to unnatural hormone levels. They looked at whether at night work was associated with a decrease to urinary 6-sulfatoxymelatonin. Participants consisted of 172 night workers and 151 day workers. All participants were nurses aged 20-49 with regular menstrual cycles. Urine samples were collected through the working day as well as during sleep periods. 6-sulfatoxymelatonin levels were found to be a significant 62% lower in night shift females versus day females. The night shift workers were also found to have continued decrease levels of melatonin even when they slept indicating a potential reason for higher risk of cancer in night shift workers versus day shift workers (Davis et al., 2012).

Researchers from the Center for Research in Epidemiology and Population Health in France conducted a study on the ill-health effects associated with women working shift work between 2005 and 2008. 3,000 women working a variety of occupation were included in the study; 11% of those women had worked at night or some form of shift work at night during their careers. Compared to those women who had never worked shift work at night, those women who had worked at night continuously or at one point of their careers were 30% higher for developing breast cancer. The risk was the particularly significant for those women who had worked night for more than four years consistently or for those women who had fast rotation of shifts between night and day (Menegaux, Truong, Anger, Cordina-Duverger, Lamkarkach, Arveux, Kerbrat, Fevotte, and Guenel, 2012). Similarly, a Danish study was published in May 2012 that revealed "women who work at least three night shifts a week for around six years or more are twice as likely to develop breast cancer" (Hansen, 2012). The study involved examining the medical records of 18,500 women in Denmark. Hansen, 2012 observed an adjusted OR of 1.4 (95% CI 0.9 to 2.1) among women with night shift experience compared to those women who had never worked night shift work in their careers. The risk ratio for breast cancer was observed to increase as number of years of night shift work increased as well as with cumulative number of shifts worked per week. Interestingly results were only significant if the women worked more than two night shifts per week. Women who worked one to two nights per week were not found to be at an increased risk when compared to women never working night shifts. This was theorized to be the case due to the disturbance to the circadian rhythm and release of melatonin not being significant enough. The most pronounced effect of night shift work on breast cancer risk was observed in women with morning chronotype preference and intense night shifts (Hansen, 2012).

In 2001 Shields conducted a study to determine an up to date profile on shift workers based on a variety of shifts worked. The National Population Health Survey was used to understand the relationship between ill-health effects as well as psychosocial disturbances and shift work. The researcher included four shifts that were self-reported: evening, rotating, night, irregular. Due to a small sample size, the night shift was unfortunately not capable of being analyzed. Results for both men and women working the evening shift resulted in a significant increase to psychological distress. Shields controlled for both personal and work stress, health related behaviors, and socio-economic factors and still found a significantly higher rate of reporting a health related chronic condition for evening, rotating, or irregular shift workers when compared to their day time counterparts. Women were found to have fewer disturbances when working the evening shift, which was equating to potential accommodations with family life that may decrease psychological distress for women. Limitations to this study include the inability to control for length of time that every individual had been working shift work.

Previous research conducted on gender specific ill-related health effects that can result from working shift work is limited. The cause of women's health problems from working shift work is still not clearly understood. Several theories have emerged to explain the ill-health effects that can result from females working shift work. Among these theories are that disturbances to the natural circadian rhythms of the body will also cause disturbances to the cycles that this rhythm coincides with including reproductive cycles, sleep patterns, and hormone release. These collective disturbances have been theorized to lead to ill-health problems (e.g. Labyak et al., 2002, p. 709). Some studies (e.g. Davis, Mirick, Chen, and Stanczyk, 2012; Chung et al., 2003) have theorized that increased risk for female related ill-health effects come from disturbances to the natural release of melatonin in the body. The research that has been conducted to date on the exact etiology of female related ill health effects from working shift work is introductory at best.

Studies that have aimed at better understanding the relationship between female related health and shift work are only preliminary and have several limitations to their methodology. Further research is needed on gender specific ill-related health effects that can result from working shift work while taking into account detailed observation of shift systems.

2.5. Health Practices in Shift Work

Below is a checklist provided by the Transportation Research Board that highlights work scheduling BEST practices. The most frequently associated reason for an increased risk of health effects in shift work is disturbances to the body's circadian rhythms as a result of inadequate and disrupted sleep. There have been several recommendations to promote good sleep hygiene and recovery by researchers. Costa, 2003 has found that adequate sleep hygiene is one of the most important factors to counteract the stresses of shift work and to improve tolerance. He equates an individuals' ability to maintain proper daily sleep regiments, including the avoidance of sleep disturbances, with a higher ability to compensate for lost sleep due to working (Costa, 2003). Placing sleep at the top of your priority will recovery from sleep debt and promote better health. There is a recommended minimum of 7 hours per night, some individuals may need more depending on natural rhythm and demands (Sherry 2005).

Work Scheduling BEST Practices
(Adopted from the TCRP Report 81)

1. Minimize sequences of very late night or very early morning shift – no more than 2 to 4 nights in succession
2. Avoid short intervals of off-time between shifts
3. Avoid working both weekend days
4. Avoid working every day of the week
5. Consider working shorter shift periods for very late night or very early morning runs
6. If on a rotating shift schedule, make sure it rotates in a forward direction rather than backwards
7. Keep your schedule as regular and predictable as possible – try to stay within an hour of shift start and end time
8. Prepare for short-term shift changes
9. Avoid relying on overtime

Figure 1 Work Scheduling Best Practices

Practicing good sleep hygiene has many factors and areas for improvement. The environment one is sleeping in has been reported to have a great deal of influence on how well an individual is sleeping. Disturbances such as television, spouse sleeping patterns, and family life can affect the sleep environment. Minimizing the presence of these sleep disturbances has been reported to aid an individual sleep longer and with better quality. The lighting in the sleep environment is recommended to be dark enough to accommodate rest. Too much light will send signals to the body that it is time to be awake and disturb the natural sleep cycle. Temperature can also play a role in sleep quality. Any room above 80F or below 65F can affect the sleep cycle and should be avoided (Shapiro et al., 1996).

Caffeine, nicotine, and alcohol intake can also have negative effects on sleeping patterns. It is recommended that caffeine and alcohol be avoided in access throughout the day, but especially at night. Nicotine acts as a stimulant that has, among several other things, been linked to a decrease in sleep quality (Akerstedt, 1996). Respecting your bedtime sequence can also promote good sleep hygiene and health. Maintaining a routine of habits before bed can get your body used to falling and staying asleep more easily. Things like always sleeping in your bed instead of falling asleep on the couch in front of a television, maintaining changing clothes and a face/body washing routine, and/or trying relaxation techniques such as reading or meditation before bedtime will add to sleepiness (Shapiro et al., 1996).

If shift work and continuous work at night is unavoidable, it is recommended to make sleep a priority whenever possible in order to avoid sleep debt and promote recovery. Sherry recommends additional recovery tools such as strategic naps, rest breaks, exercise and physical fitness as a priority to combat developing sleep debt. It is recommended that a nap be used as a mechanism to fight fatigue when sleep has been less than 5.5 hours in the sleeping environment, had 2 or more periods of wakefulness of 30 minutes of length, if "tossing and turning" was occurring, and/or if there is increased fatigue during the day. Naps are most productive when they are 15 to 30 minutes in length, never exceeding 1 hour (TCRP Report 81).

Nutritional consideration and physical fitness have also been considered in helping to alleviate or avoid potential ill-health effects. (Shapiro et al., 1996). Physical fitness has consistently been reported to promoting good health and quality of sleep. Although many shift workers and day workers struggle to integrate routine exercise into their day, higher levels of physical fitness have proven to help fight fatigue and increase tolerance to shift work (Popkin et al., 2006).

Other factors that can affect tolerance and recovery to shift and night work can be determined by looking at family and living conditions, working conditions, social conditions, and individual characteristics (Costa, 2003).

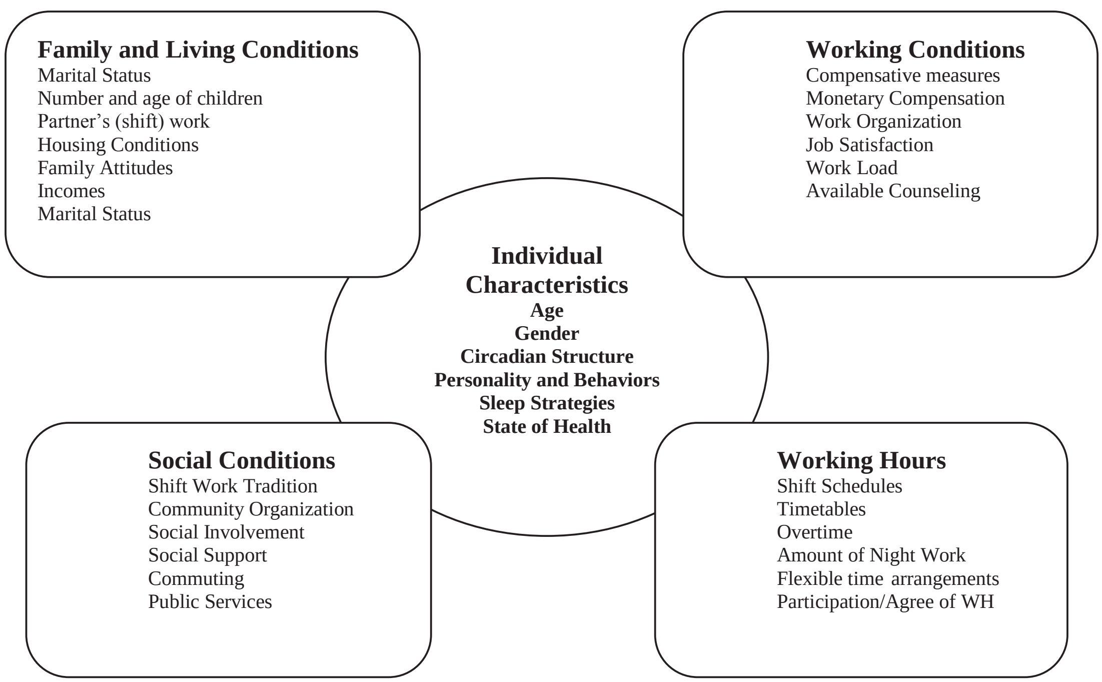

Figure 2 Adopted from: Factors that can affect tolerance to shift and night work

(G. Costa, 2003; *Factors influencing health of workers and tolerance to shift work*)

2.7 Summary

Based on the review of the literature it seems apparent that there is a relationship between the sleep disturbance and consequent disturbances to the circadian rhythm and health. It has been suggested that female shift workers have potential greater risk for gender related ill-health effects (Costa, 2003; Clayton, 2008, Barzilai-Pesach, Sheiner, Potashnik, and Shoham-Vardi, 2006, Medgal, Kroenke, Laden, Pukkala, and Schernhammer, 2005; Stevens, 2009). In a very well designed study by Sookian, Gemma, Gianotti, Burgueno, Alvarez, Gonzaolez, and Pirola, 2007, found significant differences between serotonin levels when comparing day versus night workers. Their study was among the few that quantified the nature of shift work schedules determining exact hours worked for night versus day shifts as well as exact lengths of time working shift work. Similarly, Davis, Mirick, and Stevens, 2001, investigated the risk associated with night work and breast cancer. Their study also quantified the number of hours that women had worked shift work. They determined that those women working more than 5.7 hours of shift work per week were more likely to develop breast cancer. Thus, in well-designed studies that clearly quantify the type (day versus night) and duration (number of hours worked over a period of time) show a relationship with negative health effects.

Although there are a number of studies indicating a correlation between working shift work and ill-health effects that can result, there are a number of limitations to previous research that the current study will seek to address. For example, some studies such as Labyak, Lava, Turek, and Zee, 2002, quantified what they meant by shift work but failed to incorporate length of time working shift work into their analysis. There has also been a number of studies that have sought to identify ill-related health effects from working shift work that have failed to incorporate gender analysis in their methodology (e.g. Sookoian, et al., 2007; Su et al., 2008). In addition, to date there is no known study that has directly tested the relationship between females working shift work and the disturbances to the female menstrual cycle that may result that has included satisfactory methodology and analysis of shift. Lauria, Ballard, Caldora, Massanti, and Verdecchia, 2006, for example, concluded that 62% of respondents reported menstrual disturbances, yet their findings were based on a cross-sectional study without shift work adequately quantified. In addition to this study, there is a consistent gap in sufficiently quantifying the variety of shift work schedules that exist within our workforce. Several studies have attempted to define shift work via hours (Labyak et al., 2002; Davis et al., 2001), but the majority fail to account for the length of time working shift work in addition to distinctly quantifying amount of shift work exposed to (e.g. Marquie & Foret, 1999; Lauria et al., 2006; Messing et al., 1987; Scherhammer et al., 2001). Clearly, an additional study is needed that seeks to understand the relationship between female ill-health effects with adequately quantifying shift work with concurrent analysis of duration of time working shift work.

A number of studies, regardless of their methodology, have sought to look at a variety of health effects related to shift work. Cardiovascular complications (Ellingsen, Bener, and Gehani, 2007), obesity and gastrointestinal disturbances (Van Amerlsvoot, Schouten, and Kok, 1999), and sleep disturbance (Dean et al., 2007) have been observed for both males and females. As we have read, gender specific research has looked at menstruation cycles (Costa, 2003; Labyak et al., 2002), fertility disturbances (Barzilai-Pesach, Sheiner, Potashnik, and Shoham-Vardi, 2006), and a possible increased risk for developing breast cancer (Medgal, Kroenke, Laden, Pukkala, and Schernhammer, 2005). However, the effects of shift work on psychological issues such as depression has also not been well documented. Sookian et al., 2007 attempted to understand depression in shift workers by analyzing serotonin levels of day versus night workers. One critique of their study was that while biological methods were used to assess depression, no standardized psychological measurement of depression was included. Thus additional research is needed that addresses the following concerns: 1) quantification of type and duration of shift work 2) use of appropriate psychological measures of depression 3) identification of other, less severe manifestation of biological or physical disruptions of health (ie menstrual health).

It is apparent that there is a current lack of sufficient research that has adequately tested the association between working shift work and related health problems that may result. Gaps in the literature exist within the areas of gender specific analysis, quantifying shift work, an inclusion of duration of shift work endured, and an adequate analysis of variables including menstrual disturbances and depression. The present study will seek to fill that gap within the current literature.

3. Methods and Participants

3.1. Participants

Participants will be 500 females who are currently working shift work within the transportation industry. **Inclusion criteria** for the shift working females will be (1) female gender (2) currently working shift work which will be defined as working outside of the hours of 7am to 6pm (3) participants will all be members of the transportation industry working in a variety of jobs including but not limited to: flight attendants, ground transportation workers, call-center works, mechanics, engineers, train operators and conductors. **Exclusion criteria** (1) non-female gender (2) any female over the age of 45 (3) any female unable to complete the surveys due to cognitive impairment.

3.2. Measures

The Survey of Shiftworkers (SOS) (Folkard, 1995). The Standard Shiftwork Index (SSI) was created in 1995 by the Shiftwork Research Team in the Social and Applied Psychology Unit to address the lack of standardized tools to measure shift-system designs and individual effects from working shift work. It was designed to measure the impact of a variety of shift systems on the health and wellbeing of shift workers. A shorter version of the Standard Shiftwork Index was created by the Shiftwork Research Team called the Survey of Shiftworkers (SOS). The SOS has a number of scales that include general information on shifts worked, frequency of shifts, timing and duration of shifts, regularity of shifts and workload of shifts. Demographic information including age, gender, experience of shiftwork, and domestic circumstances are also asked (Kaliterna & Prizmic, 1998). The SSI contains six sections: (1) biographical information and type of shift worked as well as job satisfaction (2) the effect of shiftwork on sleep (3) individual wellbeing including mental health (5) coping with shift work (6) sleeping habits, preference to morning or night, and personality traits of extraversion and neuroticism (Tucker & Knowles, 2008). All of the measures included are independent of each other and each produce individual scores. A major unfortunate limitation to the survey is that it lacks quantifying data on how to measure the nature of shifts; no individual scoring system was given to the questioned designed to understand the nature of shifts.

The SSI theorizes that shift work produces disturbances to the bodies sleep/wake cycle and biological circadian rhythm and psychosocial rhythms. In 2008 Tucker and Knowles reviewed 70 studies that have utilized the SSI to determine the impact of shift systems on disturbances to these rhythms. The researchers found 25 of the selected 41 studies to provide significant evidence that showed a relationship between shift working systems and disturbances to biological rhythms and psychosocial norms. For purposes of this study, only Section A to determine exact frequency, length, and nature of shift will be used. The full survey is presented in Appendix A.

The Women's Health Questionnaire (WHQ) (Hunter, 1988) was first published in 1992. The survey was given to a standardized sample of 1,090 women aged 45-65 years of age who were recruited from an ovarian screening program a King's College Hospital in

South London, UK. The WHQ is a 36-item questionnaire assessing nine domains of physical and emotional health rated on four point scales created to determine women's overall emotional and physical health. In creation of the WHQ, a factor analysis was conducted that revealed nine factors that account for 55.7% of the variance. The range of scales enable a detailed assessment of the following dimensions of women's general emotional and physical health (number of items in parenthesis): depressed mood (6) somatic symptoms (7), anxiety and fears (4), sleep problems (3), vasomotor symptoms (2), sexual difficulties (3), memory/concentration (3), attractiveness (3) and menstrual symptoms (4).

Test-retest reliability was conducted on a sample of 48 women who completed the WHQ on two occasions. All correlations were above .75, ranging from .96 to .78, suggesting that the WHQ is reliable across a two-week time interval. Concurrent validity of the mood items was assessed by comparison with the General Health Questionnaire (GHQ); the GHQ correlated .86 with depressed mood (Hunter, 2003). Scoring for the WHQ includes the four point scales for each possible answer to the items (yes definitely, yes sometimes, no not much, no not at all) are reduced to binary options (0/1) and the subscale items are added then divided by the number of items in each subscale. Norms are available for the 45–65 age range, the 45–54 age range, and the 55–65 age range as well as ages 23–38. The full survey is presented in Appendix D.

The Center for Epidemiologic Studies Depression Scale (CES-D Scale) (Radloff, 1977). The CES-D was developed by the Center for Epidemiologic Studies for use in studies of epidemiology of depression within the general population. The scale is distinct from other depression scales in that the CES-D seeks to measure current levels of depression symptomology versus clinical severity during treatment for example in an individual. The scale was developed on previously validated depression scales and by identification of the following depressive symptomology: depressed mood, feelings of guilt, feelings of worthlessness, feelings of helplessness and hopelessness, psychomotor impairment, loss of appetite, and changes to sleep. The survey contains twenty depression symptom questions. Participants identify how they have been feeling within the last week by choosing one of the following rates of severity for each item: Rarely or non of the time (less than 1 day); some or a little of the time (1-2 days); occasionally or a moderate amount of time (3-4 days); most or all of the time (5-7 days). The survey has demonstrated normal distribution within the general population. The survey has also demonstrated internal consistency in the general population (.85) and within a patient sample (.90) (use of coefficient alpha, Spearman-Brown, split-halves methods). Test-retest-correlations were also conducted that produced moderate results; ranges were higher for short test-retest intervals (.45 to .70) due to the survey measuring current depressive symptomology (Radloff, 1977). The full survey is presented in Appendix B.

Epworth Sleepiness Questionnaire (ESS) (Johns, 1991). The EES was developed in 1991 by Murray Johns at Epworth Hospital in Victoria, Australia. The survey was developed with the intention of measuring sleepiness of an individual at a particular time or event. The survey consists of 10 situations in which the subject rates how likely he or she would be to doze off during the given situation (i.e. watching TV or sitting and reading). The subject is asked to rate how likely they would be to doze off during each item from the following categorical data: would never doze, slight chance of dozing, moderate chance of dozing, or high chance of dozing. Each category is scored as either 0, 1, 2, or 3 points respectively for a maximum total of 24 points. A high level of internal consistency between the items in the survey has been measured by Cronbach's alpha, ranging from 0.73 to 0.88. Numerous studies using the ESS in data analysis have supported high validity and reliability of the measure (Smyth, 2009). The full survey is presented in Appendix E.

Menstrual Distress Questionnaire (MDQ) (Moos, 1968). The MDQ was developed in 1968 by Rudolph Moos, PhD at Standford University. The survey has been described as the most widely recognized and used tool to assess the female menstrual cycle and symptomology (Coleman & Stojanovska, 2003). The MDQ was developed by compiling 47 symptoms questions from several sources including survey, interview, previous research review, and control symptoms obtained from the Blass Menopausal Index. The MDQ was normed on a geographically representative sample of 839 female graduate students of a large western university. The scale measures eight constructs of menstrual symptomology: pain, concentration, behavioral change, autonomic reactions, water retention, negative affect, arousal, and control. Each item can be answered using four descriptive categories (no experience of symptom, present mild, present moderate, present strong, present severe). Each descriptive answer has an equal weight for every item that can be added to produce a total raw score. The full survey is presented in Appendix C.

3.3. Procedure

The research protocol, instruments and proposed methodology and procedures were submitted to the University IRB for review and approaval. An online survey composed of the above denoted surveys and questionnaires will be prepared via Survey Monkey and administered to members of the Transportation Workers Union of America. The participants will receive the survey via their work email address. A random sample of women will be recruited from the various locations throughout the country. Sampling will continue until we have obtained equal numbers of both day and night shift workers from the various locations. A non-response rate will also be accounted for with continued sampling until equal number of day and night has been obtained.

3.4. Data Collection

Women will be recruited from a number of centers that are part of the Transit Workers Union of America. A letter from the International President and VP for Health and Safety will be sent to all members explaining the nature of the study, purpose of the study, and study procedures. Individual participants will be recruited via email address provided by the center director. Participants will receive the consent form and the voluntary nature of the study will be explained to them via email. Centers will be geographically diverse with a number of women working within a variety of transportation roles with a variety of shift schedules.

3.5. Analyses

A linear multiple regression analysis will be used. A series of multiple regressions will be constructed with dependent variables of: Women's health symptoms (WHQ-II), depression symptoms (CES-D Scale), sleepiness (Epworth Sleepiness Scale), and menstrual distress symptoms (MDQ). The independent variables will consist of the number of shift work hours and by type of shift (day versus night). The association between the independent variables of amount and type of shift work with the dependent variables of the CES-D measuring depression, total raw scores on the WHQ-II measuring overall female health, total raw scores on the Epworth Sleepiness Scale measuring sleepiness, as well as total raw scores on the (MDQ) measuring disturbances to the menstrual cycle will be analyzed using linear multiple regression. In addition, to assess the role of various demographic characteristics, age, race, years of education and years working will be entered into the equation in a block prior to the other independent variables.

Example: $Y = \text{Intercept} + (Beta_{1}{*}D_1 + Beta_{2}{*}D_2 + Beta_{3}{*}D_3 + Beta_4{*}D_4 + Beta_5{*}\ D_5) + Beta_6{*}X_1 + Beta_7{*}X_2$

Y (Raw score on WHQ-II – overall health)
D_1 – gender
D_2 – age

D_3 – race
D_4 --- years of education
D_5 – years of work
X_1 (day versus night)
X_2 (number of shift work hours)

Post-hoc comparisons of interest will be made between day versus night workers and the various dependent variables. Women will be categorized into different groups based on frequency of shift work and length of time working shift work. The first grouping will be dichotomized into day versus night shift workers. Persons working between 6AM and 7PM will be termed as days (non-shift workers) and the others will be nights (shift workers). The primary analysis will include an examination of frequency of shift work and how it correlates to the occurrence of physical symptoms for women including depression, menstrual distress, and overall health including sleepiness.

A second group, frequency, will be based on the frequency of shift work. Frequency of shift work will be calculated by the total number of hours a woman has worked outside of the hours of 6AM to 7PM. The frequency of shift work will include an analysis based on total time a person has worked shift work. Frequency will be measured by total years of working shift work as well as the percentage of shift work worked in the past one year, five years, and ten years.

3.6. Sample Size

Using G*Power software (Faul, Erdfelder, Lang, and Buchner, 2007), an a priori power analysis was conducted to determine the appropriate sample size for the desired statistical analyses. For the linear multiple regression analysis with 7 predictors (see above equation) with an acceptable alpha level of .05 and a beta (power) of .95 and an expected moderate effect size (= 0.15) the total sample size would be 153.

F tests - Linear multiple regression: Fixed model, R^2 deviation from zero
Analysis: A priori: Compute required sample size
Input: Effect size f^2 = 0.15
α err prob = 0.05

Power (1-β err prob) = 0.95
Number of predictors = 7
Output: Noncentrality parameter λ = 22.9500000
Critical F = 2.0732820
Numerator df = 7
Denominator df = 145
Total sample size = 153
Actual power = 0.9503254

As indicated by G*Power, a sample of approximately 275 day and 275 night workers will be needed to effectively detect small to moderate effect sizes (d=.25) with a power of B=.90 between groups of day versus night shift workers and scores on the dependent measures would require 275 participants per group for a total of 550 participants.

t tests - Means: Difference between two independent means (two groups)
Analysis: A priori: Compute required sample size
Input: Tail(s) = One
Effect size d = 0.25
α err prob = 0.05
Power (1-β err prob) = 0.90
Allocation ratio N2/N1 = 1
Output: Noncentrality parameter δ = 2.9315098
Critical t = 1.6476390
Df = 548
Sample size group 1 = 275
Sample size group 2 = 275
Total sample size = 550
Actual power = 0.9002600

Taken together these power analyses suggest that a total sample of 550, without missing data, will be needed to detect small to moderate differences in effect size for variables of interest in the study.

4. Results

This section provides an overview of the data analysis as well as the results of these analyses. Preliminary analyses are reviewing, including analysis of missing data, internal consistency of the measures used, and power. A description of the main analysis is also provided.

Statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS). The alpha level was set at the .05 level. The size of correlation coefficients was considered small if r was .20 to .39, moderate if r was .40 to .69, large if r was .70 to .89 and very large if r was .90 to 1.0 (Cohen, 1988). To determine that strength of effect size, Cohen's (1988) guidelines were used: small effect size = .01, moderate effect size = .06 and large effect size = .14.

4.1. Preliminary analysis

Response Rate. This study utilized a confidential online survey. Female employers of the Transportation Industry were invited to participate in the survey. The Director of Health and Safety of the Transit Worker's Union (TWU), Mr. Edward Watt, distributing the email to all local chapter directors who were invited to email their female employees with the survey link and study example. A copy of the email sent to all employees is shown in Appendix G. All participants were members of the Transit Worker's Union (TWU). They received a link via their work email from a manager of operating practices that directed them to complete the online measures. In addition to email distribution in the above-described manner, this researcher was invited to address the International Women's Caucus of the Amalgamated Transit Union (ATU) where one hundred and two female transit members attended. Ninety-eight female transportation workers completed the questionnaire during the conference, which were then inputted by hand into the online questionnaire. Collectively, two hundred and sixty-six female employees responded and completed the online questionnaire. Inclusion criteria were met prior to having access to the survey, as every participant was female and a transportation worker. Of the 266 participants, 221 completed the questionnaire completely (n = 221). 16.9% of participations did not complete the survey to completion.

Missing data. Two hundred and twenty-one women completed the requisite online measures to be included in the study. Prior to running any statistical analyses, the missing data for the 221 study completers were analyzed and found to be predominately missing at the beginning of the survey. Questions with the highest frequency of missing data were questions of shift work schedule and number of hours of sleep per week. The missing data was found to be closely associated with the fact that during the first 30 days of data collection, the first two questions referenced above were not marked as "required" items to be completed by participants as the remainder of the online measures were. This was changed after roughly 30 days. Missing data on the major variables of interest (Eppworth, MSQ, WHQ, and CES-D scales) ranged from 12% to 18%. There did not appear to be a pattern to missing data on major variables and therefore was treated as random. The difficulties of determining how to handle missing data have been debated at length (Schlomer & Bauman, 2010). A recent review of missing data for purposes of statistical analysis in counseling psychology have suggested that imputation of missing results as well as mean substitution was preferable to deletion methods (Schlomer & Bauman, 2010).

Internal consistency. The reliability of measures was assessed to determine if estimates of internal consistency in this study were similar to those in the normed data. According to DeVellis (2003), the Cronbach alpha coefficient of a scale should be above 0.70. The Menstrual Symptom Questionnaire, a 46-item scale had an estimated reliability of .964, indicating reliability. The Center for Epidemiological Depression Scale, a 20-item scale yielded an estimated reliability of .91, indicating reliability. The Women's Health

Questionnaire, a 34-item scale had an estimated reliability of .89, indicating reliability and the Epworth Sleepiness Scale, an 8-item scale resulted in significant reliability at .85.

Demographic information. Demographic questions were included in the questionnaire to collect information on the participant's demographic characteristics. These demographic questions were voluntary and therefore do not represent the sample entirely. The demographic variables that were used were age, race, level of educational achievement, number of children, and marital status.

Table 1. Summary of Demographic Variables

Variable	Frequency	Missing (N)
Race	211	57
Age	216	52
Level of Education	215	53
Number of Children	133	135
Marital Status	214	5

Table 2. Overview of Demographic Characteristics

Variable	Frequency	Cumulative Percentage
Age Range		
18 to 29	9	4.2
30 to 39	34	19.9
40 to 49	74	54.2
50 to 59	75	88.9
60 or older	24	100
Race/Ethnicity		
American Indian	1	.5
Asian	1	.9
Black	83	40.3
Hispanic or Latino	11	45.5
Hispanic or Latino	11	45.5
White	115	100
Marital Status		
Single	78	36.4
Married	88	77.6
Divorced	27	90.2
In a relationship	21	100

Education		
Some High School	3	1.4
GED	10	6.0
High School Graduate	39	24.2
Some College	93	67.4
Vocational Degree	17	75.3
Associates Degree	20	84.7
Bachelors Degree	26	96.7
Masters Degree	5	99.1
Doctoral Degree	2	100.0

4.2. Distributions of Measured Variables

The mean, standard deviation, skewness, and kurtosis of each indicator variable for the study are depicted in Table 2 below. All statistics are based on a sample size of 266. Normality was examined through the plotting of residuals for each model. Histograms were examined with a normal curve placed. The histograms follow a normal distribution for each model. See figures 1-5.

Table 3. Descriptive Statistics for Measured Variables

Variable	N	M	SD	Skewness	Kurtosis	Cronbach's Alpha
Eppworth	219	8.23	5.42	.612	-.028	.85
MSQ	234	50.15	32.61	.521	-.093	.96
WHQ	220	68.94	19.06	.373	-.594	.89
CESD	223	19.1	9.41	.686	.611	.91

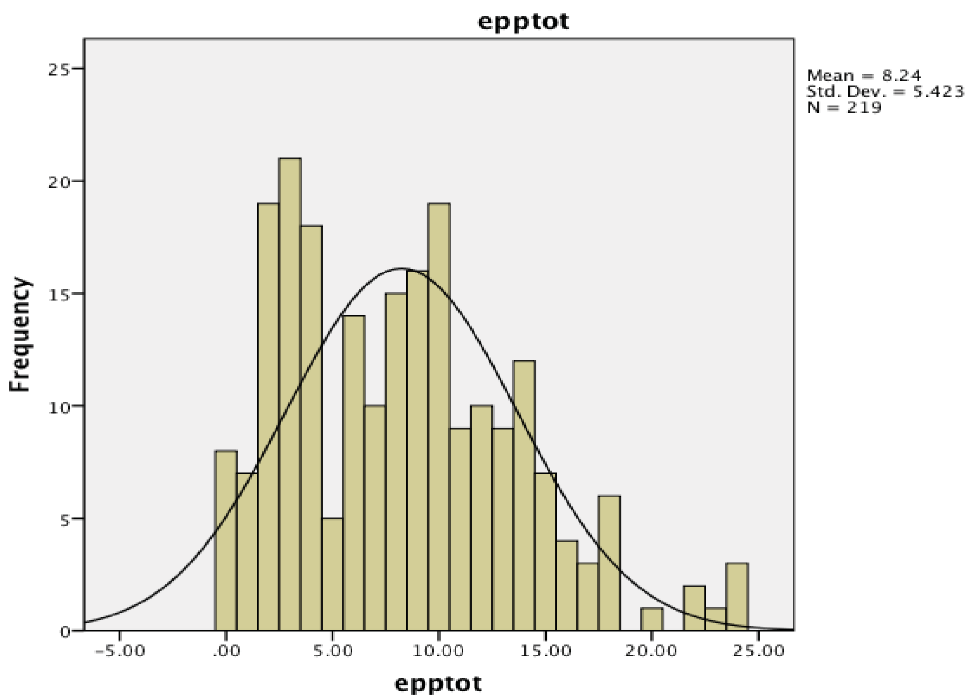

Figure 3. Distribution of the Epworth Sleepiness Scale

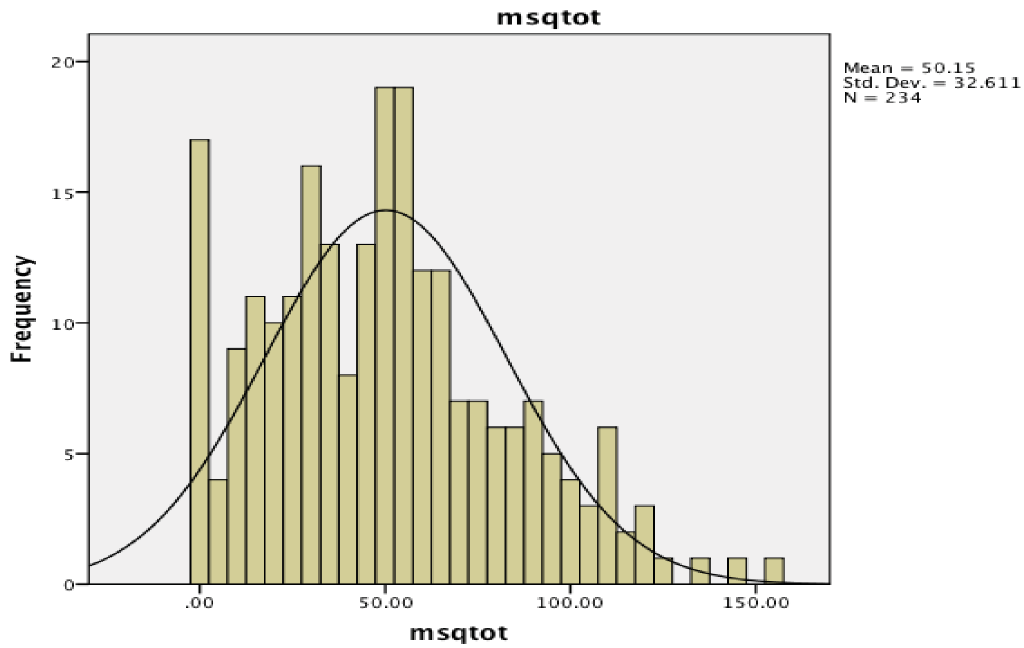

Figure 4. Distribution of the Menstrual Distress Questionnaire

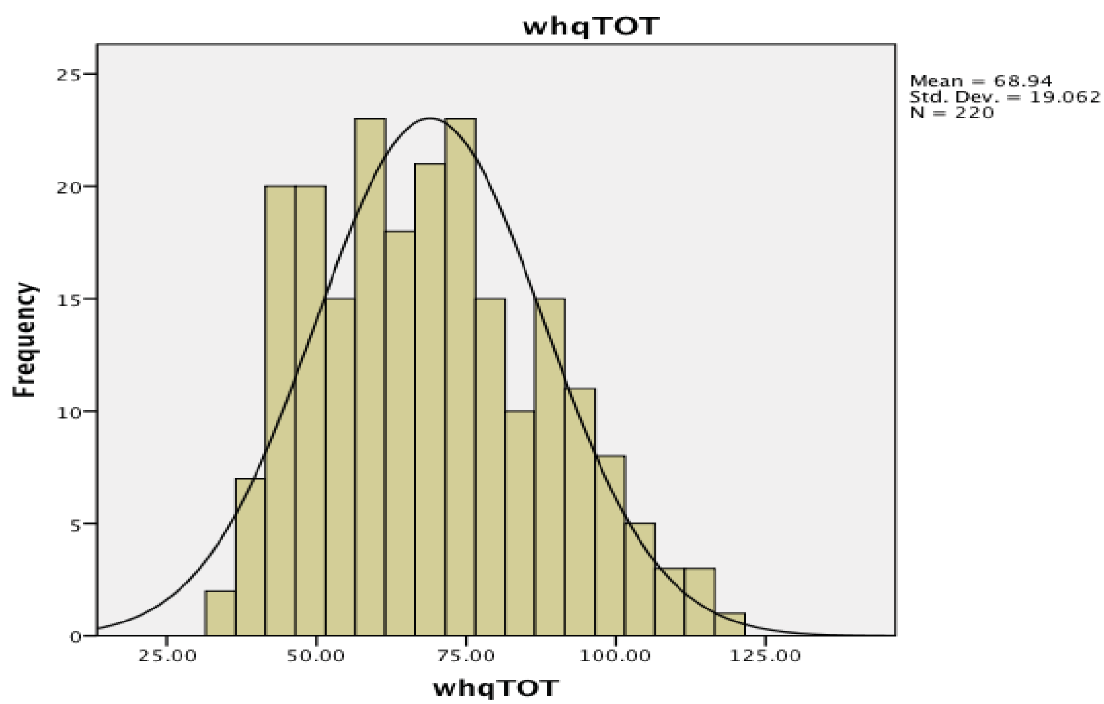

Figure 5. Distribution of the Women's Health Questionnaire.

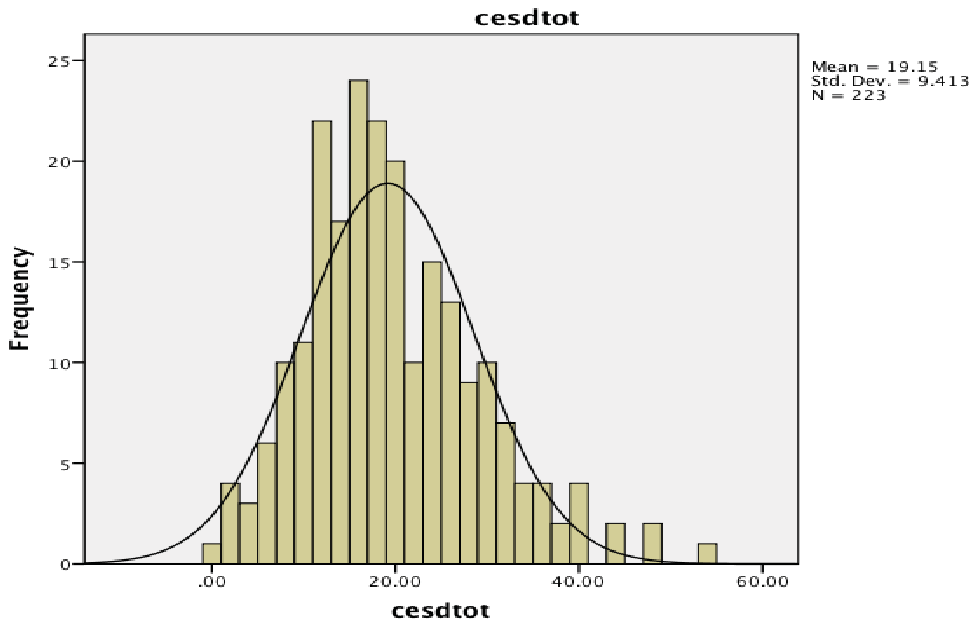

Figure 6. Distribution of the Center for Epidemiological Scale for Depression.

4.3. Post-Hoc Power Analysis

Using G*Power software, a *post hoc* power analysis was conducted to determine whether or not sufficient power was achieved in the sample to determine whether or not designated *r* is different from zero. G*Power software indicated sufficient power of 0.9661320, therefore main analyses were conducted.

Input: Correlation p H1	= 0.225
α err prob	= 0.05
Total Sample Size	= 232
Correlation p H0	= 0
Output: Lower critical r	= 0.1082571
Upper critical r	= 0.1082571
Power (1-β err prob)	= 0.9661320

Calculation of Survey of Shift Workers Questionnaire

Independent variables for purposes of main analyses were a series of questions on the Survey of Shiftworkers (SOS). These variables included total years and months working shift work, total days working during the first five years of working in the transportation industry, total days working shift work during the first five years of working in the transportation industry, total days working during the first ten years of working in the transportation industry, total days working shift work during the first ten years of working in the transportation industry, and total current days working shift work. In addition, total current frequency of hours working shift work was hand calculated to the half-hour for each participant based on a current self-reported schedule. Each half-hour a woman worked outside of the hours of 6AM to 7PM (i.e. shift work hours) was calculated as 0.5 hours of shift work. A total score was then given to each participant based on frequency of total shift work hours currently working. Table 4 presents an overview of the mean and standard deviation of the main independent variables of analysis. Figures 5 – 12 present a frequency distribution of the main independent variables of analysis.

Table 4. Descriptive Statistics for Measured Independent SOS Variables

Variable	N	M	SD
Total Current Shift Work Hours	261	7.4	10.93
Total Years Working Shift Work	251	12.7	32.61
Total Months Working Shift Work	251	4.2	3.51
Number of Days worked during first 5 years	245	5.21	0.90
Number of Days worked Shift Work in first 5 years	245	5.26	1.99
Number of Days worked during first 10 years	239	5.12	0.94
Number of Days worked Shift Work in first 10 years	239	5.20	2.03
Number of Current Days of Shift Work	239	4.38	2.38

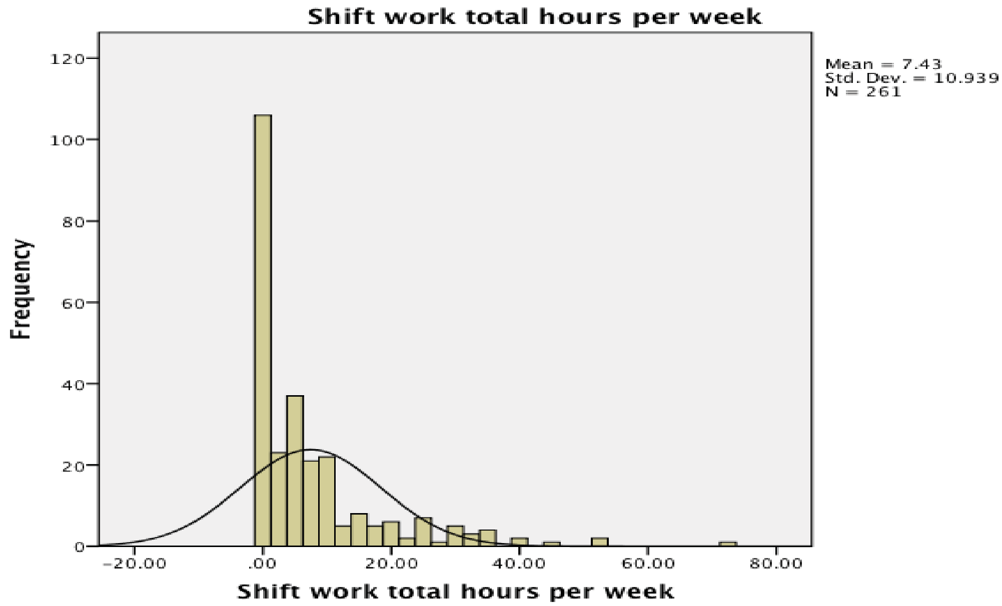

Figure 7. Frequency distribution for Total Current Shift Work Hours

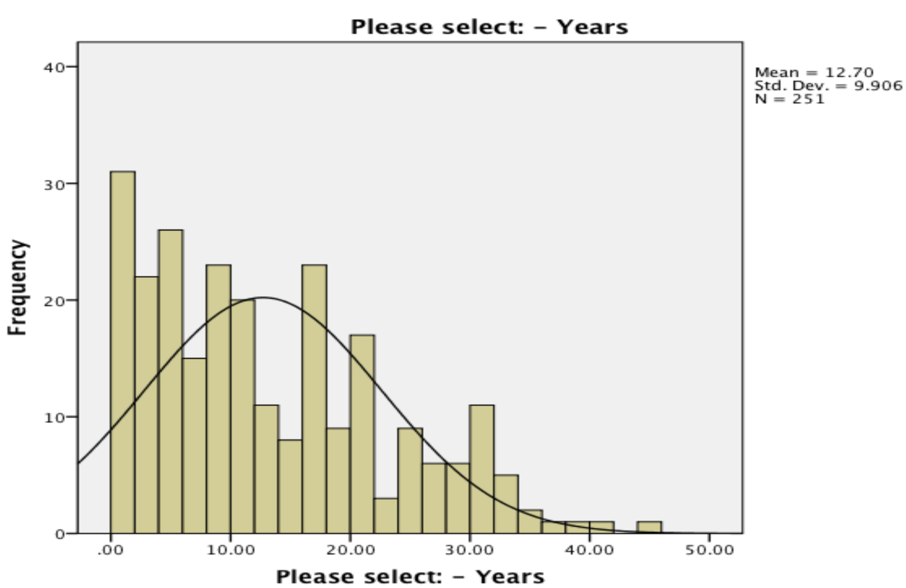

Figure 8. Frequency distribution for Total Years Working Shift Work

Figure 7 –

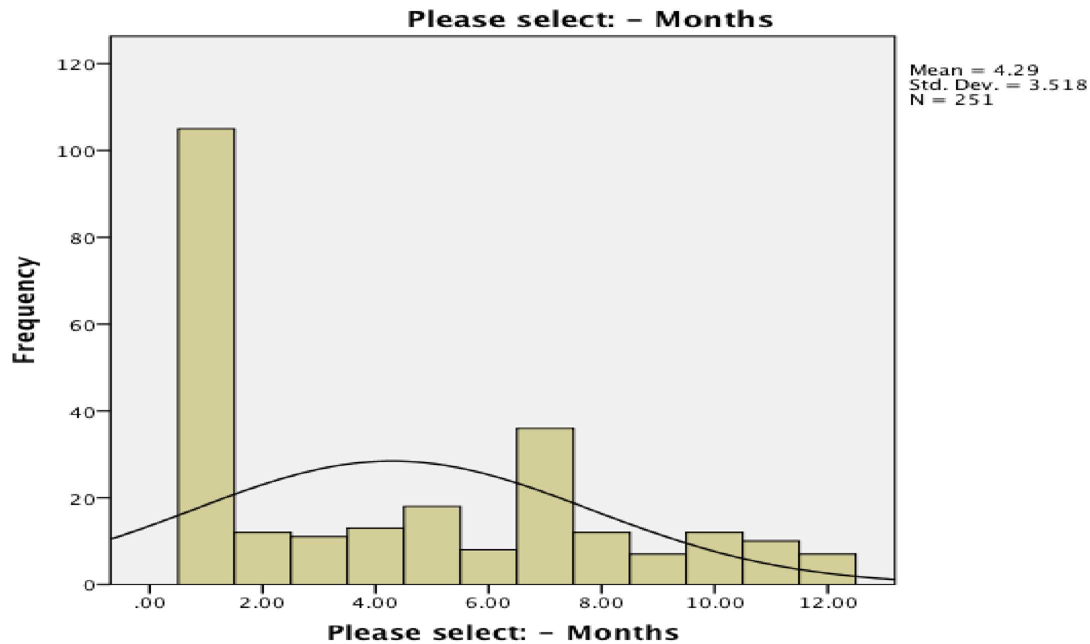

Figure 9. Frequency distribution for Total Months Working Shift Work

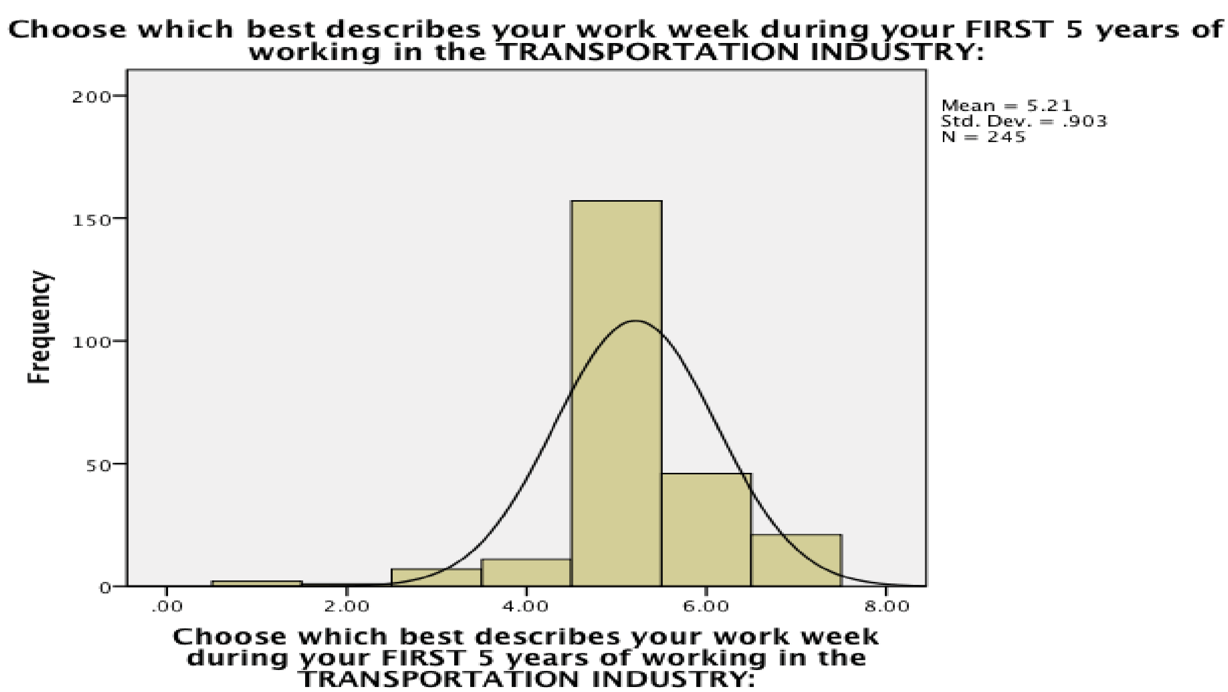

Figure 10. Frequency distribution for Total Days Worked During First 5 Years

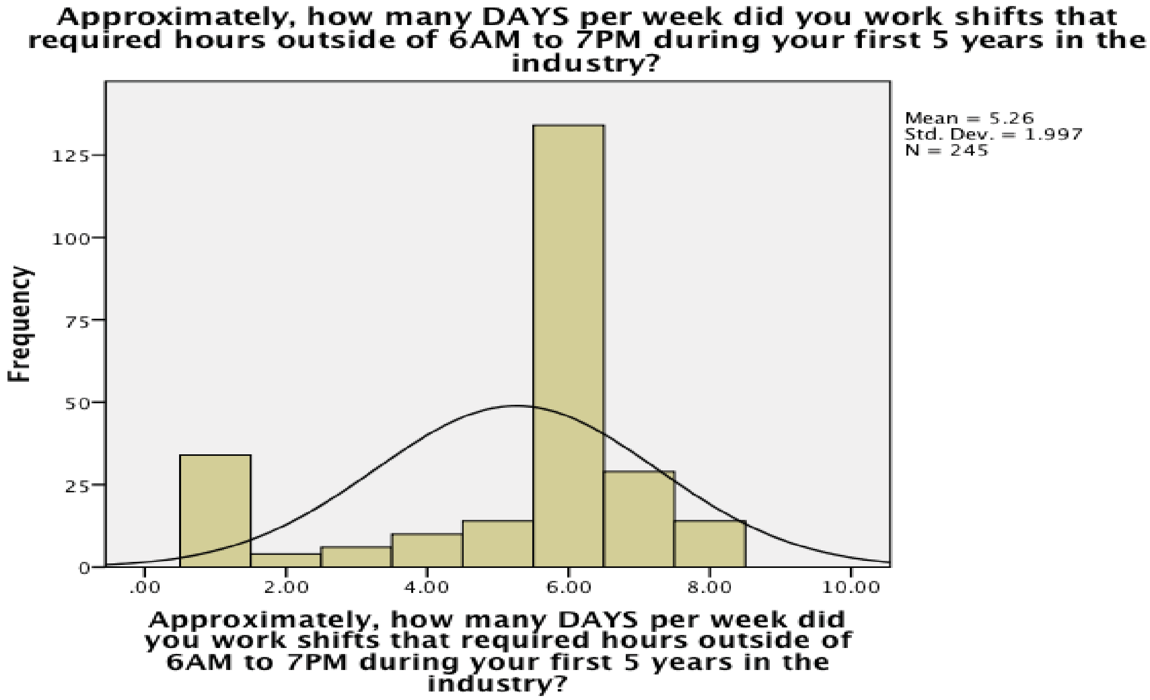

Figure 11. Frequency distribution for Total Days Working Shift Work During First 5 Years

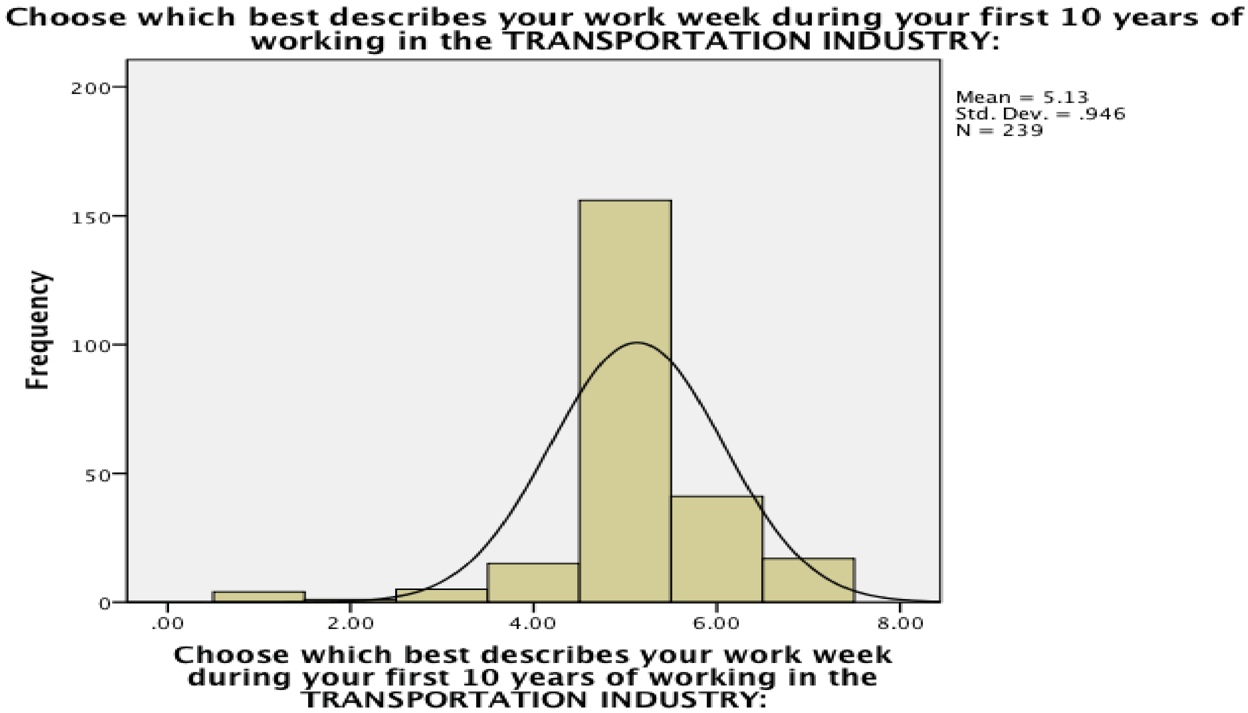

Figure 12. Frequency distribution for Total Days Worked During First 10 Years

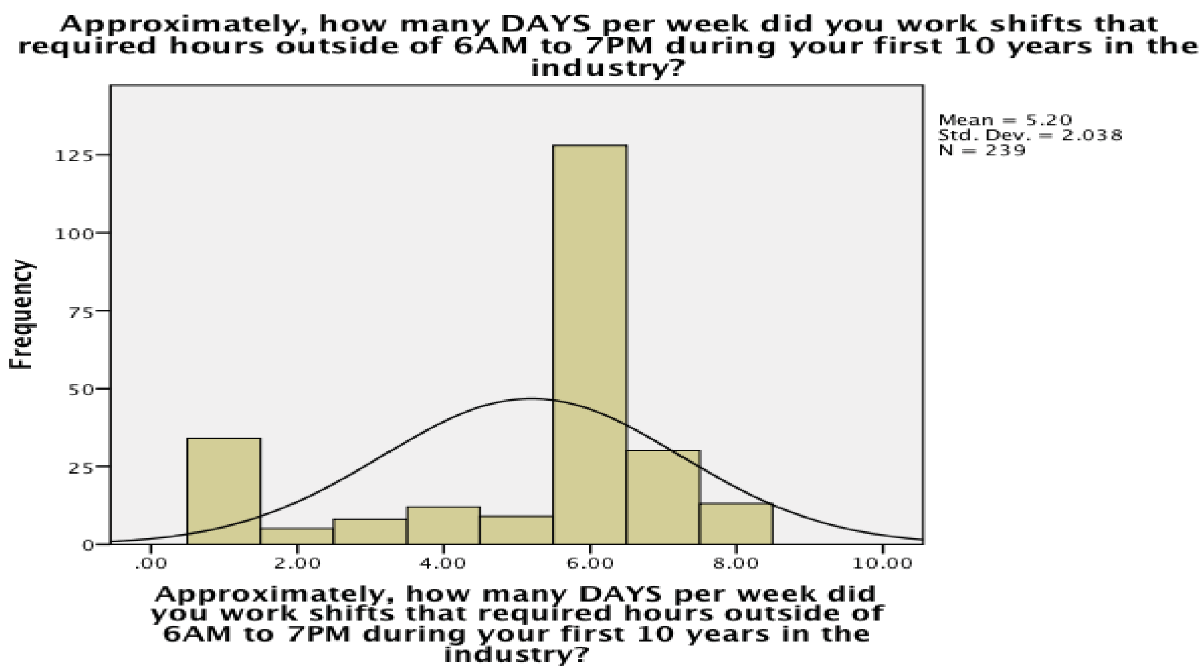

Figure 13. Frequency of Total Days Working Shift Work During First 10 Years

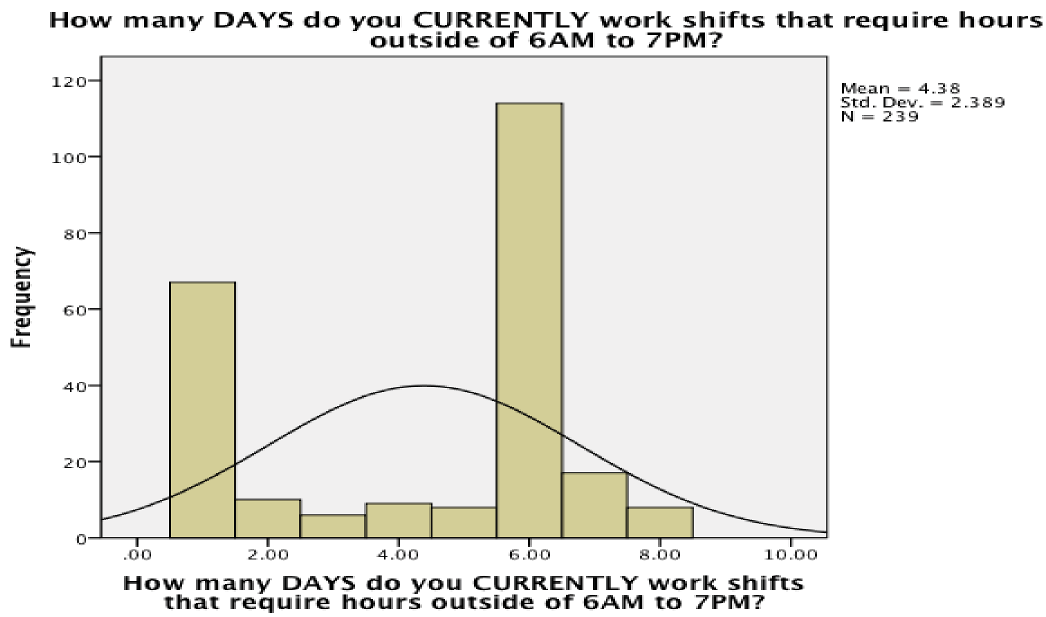

Figure 14. Frequency of Total Current Days of Working Shift Work

4.4. Shift work and depression.

It was hypothesized that females who endorse higher numbers of hours of shift work on the Survey of Shiftworkers (SOS) will also endorse higher amounts of depression symptoms on the Center for Epidemiological Studies Depression Scale (CES-D). Independent variables include total years working shift work, total days working during the first five years of working in the transportation industry, total days working shift work during the first five years of working in the transportation industry, total days working during the first ten years of working in the transportation industry, total days working shift work during the first ten years of working in the transportation industry, and total current days working shift work. CES-D total scores were entered as the dependent variable. A Pearson correlation analysis was used to determine the correlation between amount of shift work completed and symptoms of depression. Results indicated that total number of days working during the first five years in the transportation industry was significantly correlated with symptoms of depression $r^2 = .207$, $p = <.01$. Results also indicated that the total number of days working shift work during the first five years in the transportation industry was significantly correlated with symptoms of depression $r^2 = .225$, $p = <.01$ (Shown in Figure 13). The total number of days working shift work during the first ten years in the transportation industry was significantly correlated with symptoms of depression $r^2 = .185$, $p = <.01$. Current total number of days working shift work was also significantly correlated with symptoms of depression $r^2 = .76$, $p = <.01$. Current total hours of shift work per week and total days of working in the transportation industry during the first 10 years were not statistically correlated with depression. Table 5 demonstrates the Pearson correlation analysis for Hypotheses 1-5.

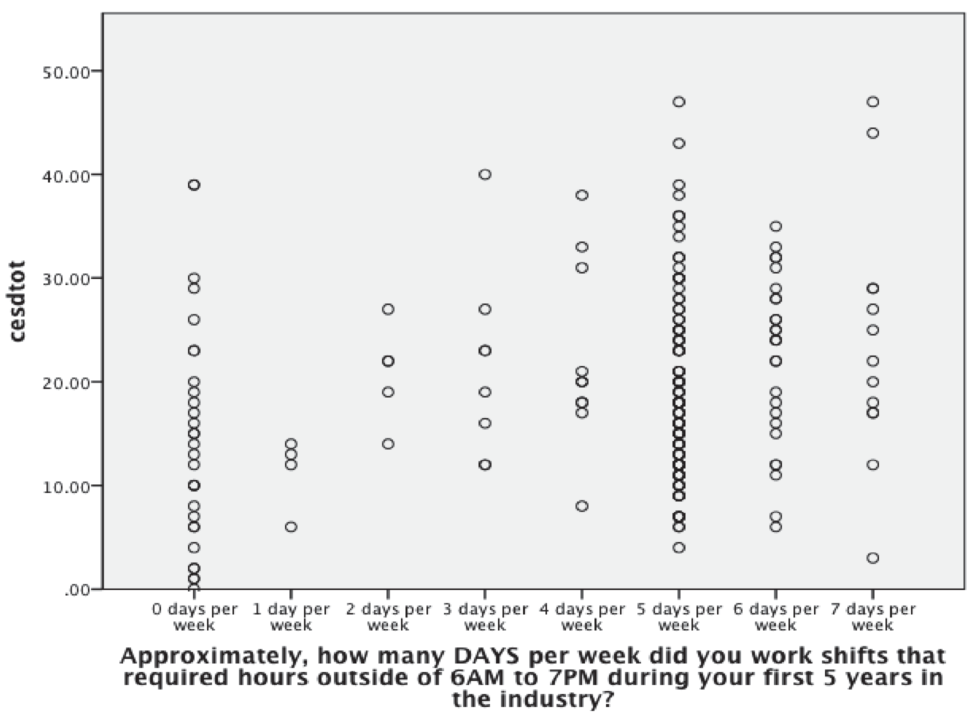

Figure 15. Depression Versus Total Days of Shift Work During the First 5 Years

Table 5 – Pearson Correlation for Hypothesis 1 – 5

	Current Shift work Total Hours Per Week	Total Years Working Shift Work	Total Months Working Shift Work	Total Days Shift Work During First 5 Years	Total Days Shift Work During First 10 Years	Total Current Days Working Shift Work
CESD total score	.063	-.058	-.037	.225**	.185**	.176**
MSQ total score	.048	.050	-.010	.221**	.197**	.148**
WHQ total score	-.055	-.038	.092	.218*	.039	.051
EPP total score	-.103	.049	.135*	.074	.080	-.020

**p<.05   ** p<.01   N = 217 to 234*

4.5. Shift work and female health.

It was hypothesized that females who endorse higher number of hours of shift work on the Survey of Shiftworkers (SOS) would also endorse higher amounts of menstrual disturbances on the Menstrual Distress Questionnaire (MDQ). Independent variables include total years working shift work, total days working during the first five years of working in the transportation industry, total days working shift work during the first five years of working in the transportation industry, total days working during the first ten years of working in the transportation industry, total days working shift work during the first ten years of working in the transportation industry, and total current days working shift work. MDQ total scores were entered as the dependent variable. Pearson's *r* was used to determine the correlation between amount of shift work completed and disturbances to the female menstrual cycle. Results indicated a statistically significant relationship between the total days working during the first five years in the transportation industry with symptoms of menstrual distress r^2 = .137, p = <.05 such that the greater the total number of days worked the more symptoms reported (See Table 5). Results also indicated that the higher the total days working shift work during the first five years in the transportation industry was also significantly correlated with symptoms of menstrual distress r^2 = .221, p = <.01 (Shown in figure 14). The higher the total days working shift work during the first ten years in the transportation industry was also significantly correlated with symptoms of menstrual distress r^2 = .197, p = <.01. The current total number of days working shift work was also significantly correlated with symptoms of menstrual distress r^2 = .148, p = <.05 (See Table 5). Current total hours of shift work per week and total days of working in the transportation industry during the first 10 years were not statistically correlated with menstrual distress.

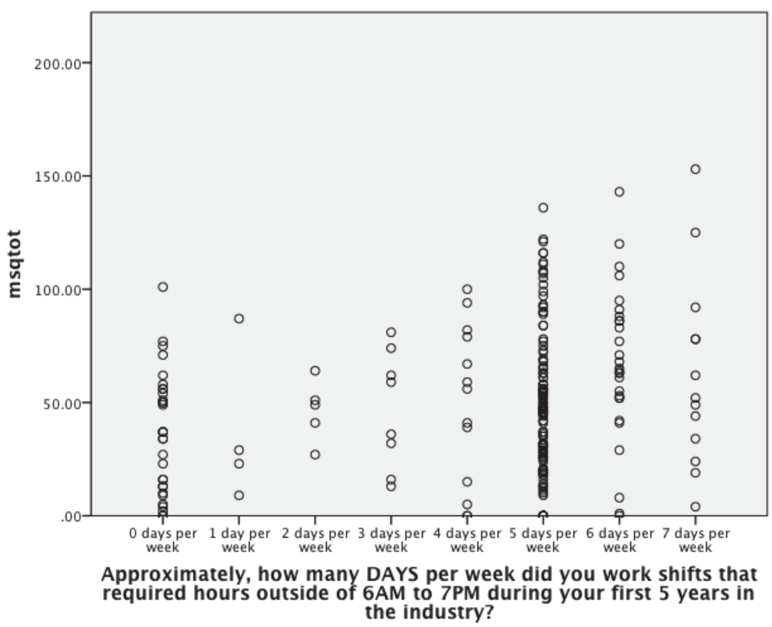

Figure 16. Menstrual Distress and Total Days of Shift Work During the First 5 Years

4.6. Hypothesis 1: Length of time as a shift worker and risk for ill-health effects.

It was hypothesized that females who endorsed higher numbers of months and years relative to the total amount of shift work on the Survey of Shiftworkers (SOS) would also report a greater frequency of menstrual disturbances on the Menstrual Distress Questionnaire (MDQ) as well as more depression symptoms on the Center for Epidemiological Studies Depression Scale (CES-D). Total years working shift work and total months working shift work were entered as the independent variables while total scores on the MDQ and CES-D were entered as the dependent variables. Pearson's *r* was used to determine the relationship between length of time as a shift work in years and months and ill-health effects reported. No statistically significant results were found (See Table 5).

4.7. Hypothesis 2: Night vs Day work and risk for ill-health effects.

It was hypothesized that females who endorse higher numbers of hours relative to the total amount of shift work at night on the Survey of Shiftworkers (SOS) would also endorse higher amounts of menstrual disturbances on the Menstrual Distress Questionnaire (MDQ) as well as higher amounts of depression symptoms on the Center for Epidemiological Studies Depression Scale (CES-D). Total current frequency of hours working shift work was hand calculated to the half-hour for each participant based on a current self-reported schedule. Each half-hour a woman worked outside of the hours of 6AM to 7PM (i.e. shift work hours/mostly night hours) was calculated as 0.5 hours of shift work. A total score was then given to each participant based on frequency of total shift work hours currently working. Pearson's *r* was used to determine the relationship between mostly shift work/night hours and scores on the MDQ as well as on the CES-D. No statistically significant results were found (See Table 5).

4.8. Hypothesis 3: Shift work and reported overall health in females.

It was hypothesized that females who endorse higher numbers of hours relative to the total amount of work on the Survey of Shiftworkers (SOS) would receive lower ratings of overall health on the Women's Health Questionnaire (WHQ). Independent variables included total years working shift work, total days working during the first five years of working in the transportation industry, total days working shift work during the first five years of working in the transportation industry, total days working during the first ten years of working in the transportation industry, total days working shift work during the first ten years of working in the transportation industry, and total current days working shift work. WHQ total scores were entered as the dependent variable. Pearson's *r* was used to determine the correlation between amount of shift work completed and ratings of overall health (See Table 5). Results indicated that the higher the total days working during the first five years in the transportation industry was significantly correlated with symptoms of overall health $r^2 = .218$, $p = <.01$ (Shown in Figure 15). Results also indicated that the amount of days working shift work during the first ten years in the transportation industry was significantly correlated with lower ratings of overall health $r^2 = .196$, $p = <.01$ (See Table 5). The total days working shift work during the first ten years in the transportation industry, current total number of days working shift work, current total hours of shift work per week, and total days of working in the transportation industry during the first 10 years were not statistically correlated with overall ratings of health (See Table 5).

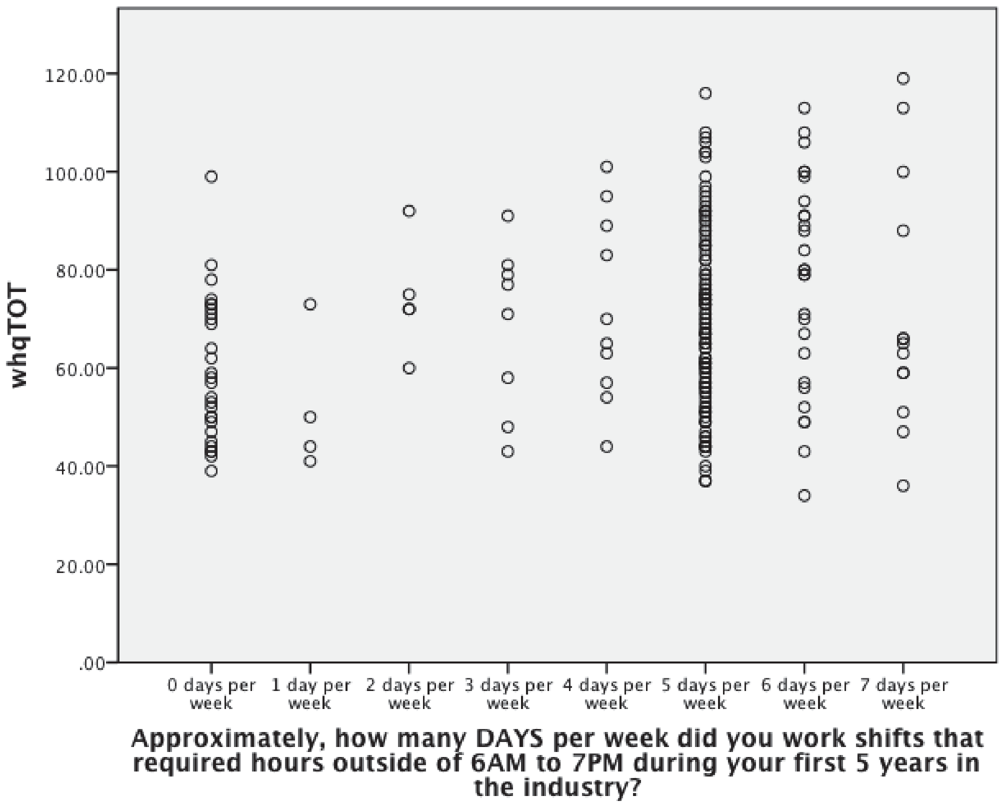

Figure 17. Overall Health Scores Versus Total Days of Shift Work for First 5 Years

4.9. Sleep Per Week/Current Level of Fatigue Analysis

To assess the role that average amount of sleep per night is correlated with symptoms of depression, menstrual distress, overall health, and fatigue, an average of total amount of hours slept per each week was calculated for each participants. Total average hours were calculated by averaging the self-reported hours and minutes per night on the SOS for each participant. Participants option for minutes on the SOS were 0 minutes. 15 minutes, 30 minutes, 45 minutes. 15 minutes was calculated as .25 of 1 hours, 30 minutes was calculated as .5 of one hour, and 45 minutes was calculated as .75 of one hour. A total hour and minutes mean score was computed based on total hours and minutes reported and total days of sleeping reported. Table 6 demonstrates the descriptive statistics for total hours slept per week.

To assess the role that sleep played into symptoms of depression, fatigue, overall reporting of health, and menstrual distress, a Pearson correlation was run between total calculated hours of sleep and total scores on the CES-D, Epworth, MDQ, and WHQ. Total hours of sleep per week was found to be negatively correlated with the Epworth Sleepiness scale, r^2 = -.213, p = <.01. Figure 16 also shows the relationship between Epworth total scores and total calculated hours of sleep per week. Epworth total scores were found to be significantly correlated with total months working shift work r^2 = .135, p = <.05. No other statistically significant results were found (See Table 5).

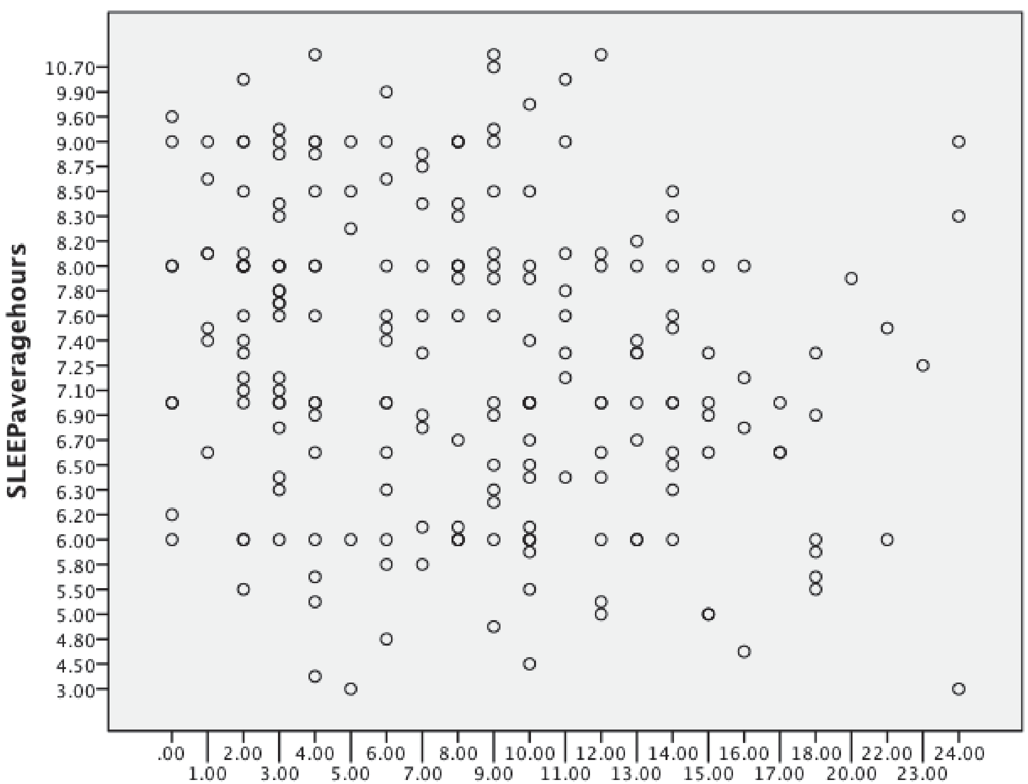

Figure 18. Average Hours of Sleep per Week and Total Scores on the *Epworth*

Table 6 – Descriptive Statistics for Total Hours Slept Per Week

	N	Minimum	Maximum	Mean	Std. Deviation
SLEEPaveragehours	257	3.00	11.00	7.3852	1.28657
Valid N (listwise)	257				

4.10. Regression Analysis

To assess the role of various demographic characteristics, age, years of education, race, marital status and years working were entered in a block prior to the other independent variables (current shift work hours per week, years working shift work, months working shift work, days per week working shift work during the first five and during the first ten years of work history, current total days working shift work, and fatigue) for each dependent variable (WHQ, MSQ, and CES-D). A stepwise regression analysis was used to determine the contribution of these characteristics in explaining the relationship between shift work and ill-health effects independently. Although there has been an extensive amount of criticism on the use of stepwise regression (Wilkingson and Dallal, 1981), the modality was chosen, as there is no underlying theory on which to base the variable selection with a large number of potentially explanatory variables (Efroymson, 1960). Tables 7-9 indicate results from each analysis.

The WHQ revealed that the Epworth total score as well as approximately how many days per week and individual worked shift work during the first five years in the industry as significantly related to WHQ total scores $F\ (1,\ 2)= 21.66,\ p\ =\ <\ .001$. The multiple correlation coefficient was .420, indicating that approximately 42% of the variance of WHQ scores can be accounted for by the linear combination of Epworth total score as well as approximately how many days per week and individual worked shift work during the first five years in the industry. The MSQ revealed that age, total years working in one's lifetime, Epworth total score, as well as approximately how many days per week and individual worked shift work during the first five years in the industry as significantly related to MSQ total scores $F\ (1,\ 4) = 11.208,\ p = < .001$. The multiple correlation coefficient was .428, indicating that approximately 42% of the variance of MSQ scores can be accounted for by the linear combination of age, total years working in one's lifetime, Epworth total score, as well as approximately how many days per week and individual worked shift work during the first five years in the industry. The CES-D revealed that Epworth total score as well as approximately how many days per week and individual worked shift work during the first five years in the industry as significantly related to CES-D total scores $F\ (1,\ 2) = 8.039,\ p = < .001$. The multiple correlation coefficient was .272, indicating that approximately 27% of the variance of CES-D scores can be accounted for by the linear combination of Epworth total score as well as approximately how many days per week and individual worked shift work during the first five years in the industry

Table 7 - Stepwise Regression of Age, Years of Education, Race, Marital Status, Years Working, Current Shift Work Hours per Week, Years Working Shift Work, Months Working Shift Work, Days per Week Working Shift Work During the First Five and During the First Ten Years of Work History, Current Total Days Working Shift Work, and Fatigue on WHQ Total Scores (n = 232)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	58.732	2.237		26.258	.000
	epptot	1.273	.226	.367	5.619	.000
2	(Constant)	48.220	3.937		12.249	.000
	epptot	1.243	.222	.358	5.607	.000
	Approximately, how many DAYS per week did you work shifts that required hours outside of 6AM to 7PM during your first 5 years in the industry?	2.003	.624	.205	3.212	.002

a. Dependent Variable: whqTOT

Table 8 - Stepwise Regression of Age, Years of Education, Race, Marital Status, Years Working, Current Shift Work Hours per Week, Years Working Shift Work, Months Working Shift Work, Days per Week Working Shift Work During the First Five and During the First Ten Years of Work History, Current Total Days Working Shift Work, and Fatigue on MSQ Total Scores (n = 232)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	69.832	7.704		9.064	.000
	How old are you?	-.582	.239	-.168	-2.436	.016
2	(Constant)	65.662	7.904		8.308	.000
	How old are you?	-1.332	.433	-.385	-3.077	.002
	How many years have you worked in your lifetime?	.871	.421	.259	2.070	.040
3	(Constant)	50.213	8.192		6.129	.000
	How old are you?	-1.106	.414	-.320	-2.671	.008
	How many years have you worked in your lifetime?	.659	.403	.196	1.636	.103
	Epptot	1.841	.389	.311	4.737	.000
4	(Constant)	34.695	9.466		3.665	.000
	How old are you?	-1.122	.406	-.325	-2.766	.006
	How many years have you worked in your lifetime?	.617	.395	.183	1.562	.120
	Epptot	1.794	.381	.303	4.707	.000
	Approximately, how many DAYS per week did you work shifts that required hours outside of 6AM to 7PM during your first 5 years in the industry?	3.300	1.068	.198	3.090	.002

a. Dependent Variable: msqtot

Table 9 - Stepwise Regression of Age, Years of Education, Race, Marital Status, Years Working, Current Shift Work Hours per Week, Years Working Shift Work, Months Working Shift Work, Days per Week Working Shift Work During the First Five and During the First Ten Years of Work History, Current Total Days Working Shift Work, and Fatigue on CES-D Total Scores (n = 232)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	16.163	1.110		14.559	.000
	Epptot	.365	.112	.222	3.246	.001
2	(Constant)	12.373	1.977		6.258	.000
	Epptot	.354	.111	.216	3.182	.002
	Approximately, how many DAYS per week did you work shifts that required hours outside of 6AM to 7PM during your first 5 years in the industry?	.722	.313	.156	2.305	.022

a. Dependent Variable: cesdtot

5. Discussion

This section includes a concise summary of the study, a discussion of the overall findings associated with each of the five research hypothesis and their implications, limitations of the study, recommendations for future research, and conclusions.

5.1. Summary of the Study

The present study was designed to determine the magnitude of the relationship between amount, frequency, and length of shift work completed by female transportation employees and the number, degree, and extent of problems related to physical, menstrual and psychological health including depression. Women employed in transportation who are working shift work on a regular basis place themselves at higher risk for developing health or psychosocial related effects. These health related outcomes can have a profound impact on an employee's job performance, daily functioning, and personal life. The present study sought to understand the potential relationship between working shift work and higher disturbances to the bodies' natural functioning. The present study has the potential for explaining new ways to decrease the risk factors for those working shift work by contributing to the overall understanding of this multifaceted relationship.

This study has many important findings and implications. Similar to prior research, (e.g. Costa, 2003; Dean et al., 2007; Reinberg & Ashkenazi, 2008, Barton, 1994; Costa; eg., Akerstedt, 1990; DeKonick, 1997; Amelsvoort, Shouten, and Kok, 1999; Lin, Hsiao, and Chen, 2009; Culpepper, 2010) that has indicated that both men and women are subject to risk of ill-health effects from working shift work, this study has implications for explaining that the effects of disturbances to the circadian rhythm as a result of certain shift work schedules can result in ill-related health effects. Additionally, this study sought to challenge limitations to current research that has been conducted on the topic as the majority of studies have been performed on men. The overall purpose of the study was to gain a better understanding of the negative effects of shift work on females working within the transportation industry. This study sought to explain the health implications specifically for female workers as fewer studies have been conducted with gender as a main analysis. Similar to prior studies, (Reinberg & Ashkenazi, 2008, Barton, 1994; Costa, 2003;) that have indicated new and additional negative health risks for females, the present study suggests that due to the circadian rhythm controlling hormone secretion within the body, disturbances to its natural rhythm can have additional effects on female cycles such as menstruation. Overall, this study offers implications for further research on females working shift work and highlights the continued importance for further exploration into recent developments. These implications have the potential to further understanding the relationship between shift work and ill-health effects, particularly the additional factors that women face.

An additional important implication of this study is that it uniquely analyzed a detailed work schedule history. The schedule of an individual working within the transportation industry is challenging to capture. Shift schedules can look vastly different from not only year to year, but week to week and day to day. Shifts schedules often rotate and do not remain constant for shift workers. This study therefore has important consequences for explaining the increased risk for ill-health effects secondary to a history of shift work as this study captured history of shift work within the past ten years. Consistent with previous research (i.e. Akerstedt, 1996), this study suggests that a longer standing history of working shift work can lead to increased risk for ill-heath effects. Previous research has theorized that ill-related health effects are caused by disturbances to physiological, psychological, and psychosocial circadian rhythms (Bambra, Whitehead, Sowden, Akers, and Petticrew, 2008) resulting from a disruption to regular sleep. Similarly, this study indicates a relationship between higher frequency of shift work within one's work history and reported ill-health effects. Overall, this study has significant implications for the importance of including a detailed work schedule history to adequately analyze risk factors for ill-health effects.

A significant strength of this study is that it was conducted solely on women working within the transportation industry. This population is quite small and difficult to reach. The collaboration of the women's caucus within each union that was utilized (TWU and ATU) aided in this research significantly, a privilege not often granted to researchers. Conducting research within this group faced its own challenges such as stigma within the transportation industry itself as well as privacy of personal issues (female health). As with many studies, various factors contribute to incomplete data. As to be expected, some of these factors affected this study. Predominately, these factors resulted in a smaller sample size than was desired therefore limiting the generalizability of the study to all women working shift work.

5.2. Specific Findings and Implications

This study contributed to the research on female related ill-health effects that can result from working shift work within the transportation industry by investigating the relationship between the amount, frequency, and length of shift work completed by transportation employees. Variables that were utilized for amount, frequency, and length of working shift work included present shift work schedule, history of shift work schedule during the first five years of working within the transportation industry, history of shift work schedule during the first ten years within the transportation industry, years working shift work, and months working shift work. Dependent variables included the number, degree, and extent of problems related to physical, menstrual and psychological health. Five hypotheses were examined using specific shift work history described above as the independent variable and the MDQ, CES-D, WHQ, and Epworth total scores as the dependent variables.

5.3. The Relationship Between Shift Work and Depression

Hypothesis one examined the relationship between shift work and depression. Previous research has indicated a higher risk for mental health disturbances including depression when working shift work (Emens, Lewy, Kinzie, Arntz, and Rough, 2009; McClung, 2011). Most studies theorize that affective disorders are related in some way to the bodies' circadian rhythm (Emens, Lewy, Kinzie, Arntz, and Rough, 2009; McClung, 2011). It has also been theorized that serotonin content is different between day workers and rotating shift workers with levels of serotonin significantly higher in those individuals working day work. Correlations between length of time working shift work and higher instances of depression have also been found (Sookoian, Gemma, Gianotti, Burgueno, Alvarez, Gonzaolez, and Pirola, 2007). Although there are a number of studies indicating a correlation between working shift work and higher instances of depression, the majority of studies often fail to incorporate gender analysis in their methodology as well as fail to capture a detailed work history of shift work. In the present research, a measure of depression was used, The Center for Epidemiological Studies Depression Scale (CES-D), as well as a detailed history of present shift work schedule, history of shift work schedule during the first five years of working within the transportation industry, history of shift work schedule during the first ten years within the transportation industry, years working shift work, and months working shift work.

A major finding of this study was that there was a significant correlation of reported symptoms of depression (i.e. higher scores on the CES-D) with higher frequency and duration of working shift work based on self-reported history of working shift work on the Survey of Shiftworkers Questionnaire. Those that had worked five days of shift work per week during their first five years within the transportation industry reported the highest scores on the CES-D, while those who had worked less than five days per week of shift work did not show a significant correlation with CES-D scores. This finding is consistent with previous research that has suggested the length of time working shift work is a significant risk factor for increased symptoms of depression (McClung, 2011). Current total days working shift work and current total hours working shift work per week did not indicate a statistically significant relationship with scores on the CES-D. These results indicate that history of working shift work is an important factor when analyzing risk for ill-health effects of shift workers. These results also imply that a relationship may exist between risk for ill-health effects such as depression and a history of working shift work regardless of current schedule. This further implies the need to consider a detailed work schedule history, as ill-health effects may be a risk even if an individual is not currently working shift work but has a history of working shift work.

5.4. The Relationship between Shift Work and the Female Menstrual Cycle

Hypothesis two examined the relationship between shift work and the female menstrual cycle. A number of previous studies have suggested that shift work can cause heavier or more painful menstrual cycles (Lauria, Ballard, Caldora, Mazzanti, and Verdecchia, 2006). Messing, Saurel-Cubizolles, Bourgine, and Kaminski (1987) found that irregular cycles, periods of amenorrhea, and longer menstrual cycles were associated with schedule variability of workers. It was concluded that regular predictable schedule variations do not seem to affect hormonal cycling in the same way as irregular or shift work schedules (Messing et. al, 1992). Furthermore, Labyak, Lava, Turek, and Zee, 2002, evaluated menstrual function and found a significant 53% of respondents reported changes in their menstrual function when working shift work. It was also found that women who experienced menstrual changes also reported significantly higher rate of sleep disturbance (Labyak et. al, 2002).

Similar to previous research (Lauria, Ballard, Caldora, Mazzanti, and Verdecchia, 2006, Labyak et. al, 2002), the current study found a significant relationship between frequency and amount of shift work and reporting of menstrual distress on the Menstrual Distress Questionnaire (MDQ). Specifically, results indicated that the higher the total days working shift work during the first five and during the first ten years in the transportation industry was significantly correlated with symptoms of menstrual distress. In addition, current total number of days working shift work was also significantly correlated with symptoms of menstrual distress. Therefore, those that had worked five days of shift work per week during their first five and first ten years within the transportation industry reported the highest scores on the MDQ, while those who had worked less than five days per week of shift work did not show a significant correlation with MDQ scores. These results were expected as they are consistent with what previous researchers have found (Lauria, Ballard, Caldora, Mazzanti, and Verdecchia, 2006, Labyak et. al, 2002). These results additionally suggest that shift work could have a relationship with the female menstrual cycle when working shift work by interfering with the natural circadian rhythm. The results also imply a need for including a history of shift work analysis when determining the relationship between menstrual disturbance and shift work.

5.5. Amount of Shift Work in Years/Months and Ill-Health Effects

Hypothesis three examined the relationship between years and months working shift work and ill-health effects. It was theorized that females who endorse higher numbers of months and years relative to the total amount of shift work on the Survey of Shiftworkers

(SOS) would also endorse higher amounts of menstrual disturbances on the Menstrual Distress Questionnaire (MDQ) as well as higher amounts of depression symptoms on the Center for Epidemiological Studies Depression Scale (CES-D). Total years working shift work and total months working shift work were used as the independent variables while total scores on the MDQ and CES-D were entered as the dependent variables. No statistically significant results were found. This result was surprising as previous literature (Lauria, Ballard, Caldora, Mazzanti, and Verdecchia, 2006, Labyak et. al, 2002) supports the idea that longer periods of working shift work may result in higher risk for ill-health effects. For example, Shapiro et al., 1997 found that the dangers of heart trouble seem to increase with the duration of years of working shift work. Van Amelsvoort, Schouten, and Kok, (1999) observed a relationship between obesity and length of time working shift work. Specifically, of those women who never performed shift work, a BMI mean was observed at 23/kgm2. Women who had worked up to 2 years of shift work had a slight increase BMI mean of 24.1, while women working 5 years of shift work had a mean BMI of 24.3. The relationship between BMI and duration/length of time in years and months of shift work was found to significantly correlate. In addition, Scott, Monk, Luann, and Brink (2007) sought to understand the relationship between shiftwork and Major Depressive Disorder (MDD). Results also yielded a correlation between increased exposure, specifically 20 years or more of working shift work, with an increased risk for MDD. Similarly, a Danish study was published in May 2012 that revealed “women who work at least three night shifts a week for around six years or more are twice as likely to develop breast cancer” (Hansen, 2012).

Results of the current study were therefore surprising as they are contradictory to previous research findings (Scott, Monk, Luann, and Brink, 2007, Hansen, 2012). The results are also inconsistent to other statistically significant results in this study such as number of days working shift work during the first five and ten years working within the transportation industry and overall scores on the MDQ and CES-D. There are several potential explanations for these non-statistical findings that need to be considered. The Survey of Shiftworker's (SOS) was utilized to attempt to capture an individual's shift work schedule. However, an explanation of shift work was included in the question regarding years and months of working shift work. The question regarding years and months was designed as follows: *how long* ***altogether*** *have you been working shift work (ie a schedule that includes any shifts outside of the hours of 6AM to 7PM) years and months?* Adding this measure and explanation of shift work hours could have potentially confused participants and therefore confounded their ability to accurately answer the question. Participants may also have had a difficult time self-calculating total years and months due to inability to remember total shift work schedules throughout one's work history. The measure and question in and of itself may have also confounded results as an explanation of shift work may have negated the measure's reliability and validity. In addition, the fact that this researcher attended the women's international caucus meeting for ATU may have confounded results in some way due to a non-random sample.

5.6. The Relationship Between Shift Work and Overall Health

Hypothesis five examined the relationship between shift work and reports of overall health in females. It was hypothesized that females who endorse higher numbers of hours relative to the total amount of work on the Survey of Shiftworkers (SOS) would receive lower ratings of overall health on the Women's Health Questionnaire (WHQ). Results indicated that the higher the total days working shift work during the first five and during the first ten years in the transportation industry were significantly correlated with symptoms of lower reports of overall health. Therefore, those that had worked five days of shift work per week during their first five and first ten years within the transportation industry reported the highest scores on the WHQ, while those who had worked less than five days per week of shift work did not show a significant correlation with WHQ scores. This finding is consistent with previous research that indicates an increased risk of ill-health effects for females while working shift work (Costa, 2003; Clayton, 2008, Barzilai-Pesach, Sheiner, Potashnik, and Shoham-Vardi, 2006; Medgal, Kroenke, Laden, Pukkala, and Schernhammer, 2005; and Stevens, 2009). The total days working shift work during the first ten years in the transportation industry, current total number of days working shift work, current total hours of shift work per week, and total days of working in the transportation industry during the first 10 years were not statistically correlated with overall health. These results again support the need to incorporate a detailed work history of shift work when exploring the correlation between shift work and ill-health effects. The significant relationship between overall reports of poorer health and a history of working shift work during one's first five and ten years of working that was found in this study suggests the possibility of an increased risk factor for ill-health with any shift work history regardless of current schedule.

5.7. Stepwise Regression Analysis

To assess the role of various demographic characteristics, age, years of education, race, marital status and years working were entered in a block prior to the other independent variables (current shift work hours per week, years working shift work, months working shift work, days per week working shift work during the first five and during the first ten years of work history, current total days working shift work, and fatigue) for each dependent variable (WHQ, MSQ, and CES-D). A stepwise regression analysis was used to determine the contribution of these characteristics in explaining the relationship between shift work and ill-health effects independently.

Analysis of the WHQ revealed the number of days working shift work during the first five years in the transportation industry as well as current level of fatigue (total score on the

Epworth) independently contributed to the model. Analysis of the MSQ revealed that age, the number of days working shift work during the first five years in the transportation industry, number of years working within the transportation industry, as well as current level of fatigue (total score on the Epworth) independently contributed to the model. Finally, analysis of the CES-D revealed the number of days working shift work during the first five years in the transportation industry as well as current level of fatigue (total score on the Epworth) independently contributed to the model.

With Epworth total scores, or levels of fatigue, significantly contributing to each dependent variable, consideration must be paid to how fatigue may explain results of the current study. Previous research has suggested that women potentially have greater difficulty adjusting to the demands of shift work and fatigue compared to males (Marquie & Foret, 1999). In addition, it is important consider previous studies that have demonstrated that if a cycle continues of depriving the body of sleep as a result of working shift work, fatigue is cumulative leading to sleep debt and increased risk for ill-health effects (Dean et al., 2007). Taken together, the nature of fatigue has potential of explaining why ill-health effects were statistically correlated with a history of working shift work, but not necessarily with current shift work schedules. In other words, if women with a significant shift work history never fully recovered or adjusted to their schedules, resulting in continued fatigue, their ill-health effects may show regardless of current schedule.

In addition, with consideration to gender and fatigue, previous studies have demonstrated that a possible explanation for ill-health effects in female shift workers ties back into interruptions in sleep patterns, and consequently interruptions to the natural circadian rhythm. However, conclusions were drawn that this may be the result of gender differences in disturbances to the circadian sleep/wake rhythm, including a decline in sleep length, increased fragmentation of sleep, and increased sleepiness and fatigue during their shift compared to male co-workers (Labyak et al., 2002, p. 704). A survey conducted in 1993 of 2,988 United States shift workers revealed significant shorter sleep periods for women aged 18 to 49 when compared to their male counterparts (Tepas, Duchon, and Gersten, 1993).

5.8. Implications

Although there has been an extensive amount of research conducted on ill-health effects that may result from working shift work, little research has been conducted on gender specific risks that may result. This study contributed to the current literature by studying gender specific factors that may result from working shift work independent of male co-workers. This study also uniquely contributed to the current literature by taking an extensive shift work history into account. Frequency and amount of days working shift work during one's work history were shown to have a relationship with ill-health effects such as symptoms of depression, menstrual disturbance, fatigue, and overall poorer reports of health.

This study has wider implications for the transportation industry as there are millions of individuals who utilize America's transportation industry on a daily basis for personal and professional reasons. It is of national importance that this industry is able to operate efficiently and safely. Within that efficiency lies the physical and mental health of the industries' employees. The current study suggests that there may need to be additional safeguards and measures taken to decrease the potential risk factors for those working shift work. For example, scheduling individuals in a way that decreases frequency and duration of shift work has the potential to decrease ill-health risk factors. Additional suggestions, to decrease the potential negative impact of shift work on women's health might also be to:

1. Minimize scheduling of very late night or very early morning shift.
2. Do not allow short intervals of off-time between shifts.
3. Do not allow working both weekend days or every day of the week.
4. Offer shorter shift periods for very late night or very early morning runs.
5. Schedule shifts that rotate in a forward direction rather than backwards.
6. Keep schedules as regular as possible.
7. Do not allow relying on overtime.

However, additional research is needed to be able to determine the efficacy of these proposed countermeasures.

In addition to providing potential guidelines for policy, this study can aid shift workers in understanding the risks associated with their schedules and help them to reduce their risks. Identifying what increases risk of ill-related health effects will be useful for decreasing risk for these potentially negative outcomes. Each individual will have a unique situation as all shift workers will have varying influences working for and against them (i.e. social conditions, family conditions, working conditions, and working hours). Understanding this dynamic may be useful in determining areas to decrease stress, and increase sleep and tolerance to shift work. Increasing sleep hygiene, avoiding alcohol and tobacco, the use of exercise, and eating well can all aid in tolerance to shift work (Shapiro et, al 1996).

5.9. Study Limitations

Although there are several positive findings and implications that have resulted from the present study, there are several limitations to the current study that need to be considered. One limitation to the study is that the study was conducted on transportation female employees only. Results should not necessarily be generalized to other professions of individuals working shift work without careful consideration to other factors that may exist. For example, Medgal, Kroenke, Laden, Pukkala, and Schernhammer (2005) found that airline crew workers who worked international or long-distance flight service (i.e. shift work) that involved circadian rhythm disturbances experience an increase risk for ill-health when the additional experience of jet lag was considered. Additional factors such as jetlag that may exist in other professions that require shift work must be taken into account before generalizing results of this study.

A second limitation to this study is that the randomization of the sample may have been confounded by attending the International Women's Caucus Meeting hosted by ATU. Although all female transportation workers of both the ATU and TWU had equal opportunity to participate in the study, attending the ATU meeting may have skewed the data in some way. Of most concern, the vast majority of women who attended the ATU women's meeting were older and potentially could have had higher risk for health problems based on age alone. This may have been the result of age significantly contributing to findings within the stepwise regression analysis and overall scores on the MDQ. Some older women may have potentially answered questions on the MDQ based on symptoms of menopause or memory rather than current menstrual distress. The attending members also had direct access to the study with allotted time to fill out the survey, which other participating members may have not had the privilege of having (i.e. no access to email or inability to complete the survey due to lack of designated/approved time at work). Future research may want to consider age as an exclusion criteria when studying women's health to account for menopause.

A third limitation of the current study is that a larger sample was desired than was actually collected. There were several contributing factors to a smaller sample size that need to be considered. The director of Health and Safety of the TWU, Mr. Edward Watt, had originally planned to email all TWU female transportation workers directly. However, he was denied access to email employees directly without approval from local chapter supervisors. Instead, access was granted to email all local chapter supervisors with the email describing the study. All chapter supervisors were asked to invite each of their female employees to participate via email (see Appendix G for email sent to all local chapter supervisors and employees). Although all local chapters were invited to participate, several participants were more than likely lost if local chapter supervisors did not email their workers. Consideration to each local chapter's supervisor must be taken into account as some supervisors were more than likely more willing to support the study than others. In addition, several members of both the TWU and ATU are flight attendants. It was pre-determined that flight attendants would not be included in the study due to additional factors not captured within the designated measures such as experience of jetlag and changing of time zones that may have confounded results. Several participants within the TWU and ATU were therefore not eligible to participate.

Measures for this study were selected based on previous research and all demonstrated sufficient reliability and validity, although several limitations to the scales should be discussed. The Survey of Shiftworkers (SOS) in particular is a measure that was created to address the lack of standardized tools to measure shift-system designs and individual effects from working shift work. Although it was designed to measure the impact of a variety of shift systems on the health and wellbeing of shift workers, it fails to incorporate a detailed enough shift work history schedule. Questions were therefore added by the researcher to capture the work history of a shift worker including total years, months, number of days working shift work during the first five and during the first ten years. The additional questions therefore lacked sufficient validity and reliability based on a lack of previous research. The additional questions may have also confused participants and therefore confounded their ability to answer them accurately. Participants may also have had a difficult time calculating their work history based on an inability to accurately remember.

5.10. Suggestions for Future Research

Results from the current study may be more generalizable if conducted on females working shift work within a variety of professions, not just limited to the transportation industry. Careful consideration would need to be paid to factors that affect disturbances to the circadian rhythm based on occupation and individual circumstances.

One of the most important contributions this study has made to the current literature is that a detailed work history of working shift work is invaluable when attempting to understand the relationship between ill-health effects and shift work. Future research should therefore attempt to determine the exact amount, frequency, and length of history of working shift work regardless of current work schedules. In addition, although this study contributed to the current lack of research conducted specifically on women, future research should consider that women have additional risk factors when working shift work based on the nature physiology of their bodies. Future research should therefore avoid trying to understand the relationship between shift work and ill-health effects without considering gender.

5.11. Conclusions

Although there has been a number of previous research studies that indicate working shift work can potentially increase an individual’s risk for ill-related health effects, more research is needed on gender specific contributions to this relationship. The current study demonstrated that a female’s shift work schedule has a relationship with increased risk for ill-health effects including menstrual distress, depression, fatigue, and overall lower reports of health. The presence of these ill-health effects may have a negative impact on productivity and job performance. Understanding this multi-faceted relationship has the potential for influencing both policy and individual practices for minimizing the poor health of our female transportation workers nationally.

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APPENDIX A – Survey of Shift Workers

1. Please circle your Race:

American Indian	Asian	Black	Hispanic or Latino	White	Other

2. Number of years of Education (e.g. High school = 12 years): ________________.

3. How old are you (e.g. 35 yrs, 4 months): _________________.

4. Please circle your Marital Status:

Single	Married	Divorced	In a Relationship

5. How long have you worked altogether? (lifetime years of work) ______________.

6. Length of time in current position (e.g. 2 yrs, 3 months): ___________________.

7. Please indicate your job title: __________________

8. What is your REGULAR work schedule (circle the days you USUALLY work and indicate what time you USUALLY start and end your shift):

M	T	W	TH	F	S	S
Star Time: ____	Start: ____	Start: ____	Start: ____	Start: ____	Start: ____	Start: ____
End/Time:___	End:___	End:___	End:___	End:___	End:___	End:___

9. How long (on average) does it take for you to commute to work? ___________.

10. How long **altogether** have you been working shift work (ie a schedule that includes any shifts outside of the hours of 6AM to 7PM)?

__________ years _________ month

YOUR WORK HISTORY:

Think about a FIVE day week that you typically worked during your first few years of work. If ALL FIVE days that you worked involved shifts even partially outside of a typical 7AM to 6PM type schedule, then you would have worked shift work 100% of the time during that week.

FOR EXAMPLE, if you worked:

- ONE shift with hours outside of 7AM to 6PM per week then you worked 1/5 or 20% of the time as a shift worker
- TWO shifts with hours outside of 7AM to 6PM per week then you worked 2/5 or 40% of the time as a shift worker
- THREE shifts with hours outside of 7AM to 6PM per week then you worked 1/5 or 60% of the time as a shift worker
- FOUR shifts with hours outside of 7AM to 6PM per week then you worked 1/5 or 80% of the time as a shift worker
- FIVE shifts with hours outside of 7AM to 6PM per week then you worked 1/5 or 100% of the time as a shift worker

Check which one best describes the amount of shift work you worked during your first FIVE years of working in this INDUSTRY:
___ 20% ___ 40% ___ 60% ___ 80% ___ 100%

Check which one best describes the amount of shift work you worked during your first TEN years of working in this INDUSTRY:
___ 20% ___ 40% ___ 60% ___ 80% ___ 100%

Check which one best describes the amount of shift work you worked during your first 15 years of working in this INDUSTRY:
___ 20% ___ 40% ___ 60% ___ 80% ___ 100%

Check which one best describes your current amount of shift work in the INDUSTRY:
___ 20% ___ 40% ___ 60% ___ 80% ___ 100%

APPENDIX B – CES-D Scale

Instructions for Questions: Below is a list of the ways you might have felt or behaved. Please tell me how often you have felt this way **during the past week.**

1.	I was bothered by things that done usually bother me
2.	I did not feel like eating; my appetite was poor
3.	I felt that I could not shake off the blues even with the help of my family or friends
4.	I felt that I was just as good as other people
5.	I had trouble keeping my mind on what I was doing.
6.	I felt depressed
7.	I felt everything I did was an effort.
8.	I felt hopeful about the future.
9.	I thought my life had been a failure.
10.	I felt fearful.
11.	My sleep was restless.
12.	I was happy.
13.	I talked less than usual.
14.	I felt lonely.
15.	People were unfriendly.
16.	I enjoyed life.
17.	I had crying spells.
18.	I felt sad.
19.	I felt that people disliked me.
20.	I could not get “going”.

APPENDIX C – Menstrual Distress Questionnaire (MDQ)

The list on the right shows common symptoms and feelings associated with menstruation. For each item, choose the descriptive category below that best describes your experience during the time of your period.

That is, for each item, decide whether you have " no experience of symptom", or whether your experience is " present, mild" "present, moderate", "present, strong" or "present, severe. If none of the categories exactly describes your experience, choose the one that most closely matches what you feel.

	None 0	Mild 1	Moderate 2	Strong 3	Severe 4

1.	Muscle Stiffness
2.	Headache
3.	Cramps
4.	Backache
5.	Fatigue
6.	General Aches and Pain
7.	Weight Gain
8.	Skin Blemish
9.	Painful or Tender Breasts
10.	Swelling (breasts or abdomen)
11.	Dizziness
12.	Cold Sweats
13.	Nausea, Vomiting
14.	Hot flashes
15.	Loneliness
16.	Anxiety
17.	Mood Swings
18.	Crying
19.	Irritability
20.	Tension
21.	Feeling Sad or Blue
22.	Restlessness
23.	Insomnia
24.	Forgetfulness
25.	Confusion
26.	Poor Judgment
27.	Difficulty Concentrating
28.	Distractibility

29.	Minor Accidents
30.	Poor motor coordination
31.	Poor Work/School Performance
32.	Take Naps, Stay in Bed
33.	Stay at home
34.	Avoid Social Activity
35.	Decreased Efficiency
36.	Affectionate
37.	Orderliness
38.	Excitement
39.	Feelings of well-being
40.	Bursts of energy, activity
41.	Feelings of suffocation
42.	Chest pains
43.	Ringing in the ears
44.	Heart pounding
45.	Numbness, tingling
46.	Blind spots, fuzzy vision

APPENDIX D – Women's Health Questionnaire (WHQ)

Please indicate how you are feeling now, or how you have been feeling THE LAST FEW DAYS, by putting a tick in the correct box in the answer to each of the following items:

	Yes, Definitely	Yes, Sometimes	No, Not Much	No, Not At All

1. I wake early and then sleep badly for the rest of the night	
2. I get very frightened or panic feelings for apparently no reason at all	
3. I feel miserable and sad	
4. I feel anxious when I go out of the house on my own	
5. I have lost interest in things	
6. I get palpitations or a sensation of "butterflies" in my stomach or chest	
7. I still enjoy the things I used to	
8. I feel life is not worth living	
9. I feel tense or "wound up"	
10. I have a good appetite	
11. I am restless and can't keep still	
12. I am more irritable than usual	
13. I worry about growing old	
14. I have headaches	
15. I feel more tired than usual	
16. I have dizzy spells	
17. My breasts feel tender or uncomfortable	
18. I suffer from backache or pain in my limbs	
19. I have hot flushes	
20. I am more clumsy than usual	
21. I feel rather lively and excitable	
22. I have abdominal cramps or discomfort	
23. I feel sick or nauseous	
24. I have lost interest in sexual activity	
25. I have feelings of well-being	
26. I have heavy periods	
27. I suffer from night sweats	
28. My stomach feels bloated	
29. I have difficulty in getting off to sleep	
30. I often notice pins and needles in my hands and feet	
32. I feel physically attractive	
33. I have difficulty in concentrating	
35. I need to pass urine/water more frequently than usual	
36. My memory is poor	

APPENDIX E - The Epworth Sleepiness Scale

Directions: Use the following scale for each situation
0 = no chance of dozing
1 = slight chance of dozing
2 = moderate chance of dozing
3 = high chance of dozing

How likely are you to doze off or fall asleep in the following situations?

Situation	Chance of dozing
Sitting and reading	
Watching TV sitting in a public place (e.g. theatre)	
As a passenger in a car for an hour	
Lying down to rest in the afternoon	
Sitting and talking to someone	
Sitting quietly after lunch without alcohol	
In a car, while stopped for a few minutes in traffic	
Total	Max 24

APPENDIX F – Shift Work Survey

Use the scale below to respond to the following items:

To a little or No Degree	To a Slight Degree	To a Moderate Degree	to a Considerable Degree	to a Very Great Degree
1	*2*	*3*	*4*	*5*

To What Degree ...(circle the number that corresponds to your answer….)

9. ... do you come to work fully rested and alert	**1 2 3 4 5**
10. ... do you find it hard to concentrate on your job	**1 2 3 4 5**
11. … has fatigue affected your job performance in the last week	**1 2 3 4 5**
12. … have you been drowsy on the job in the last week	**1 2 3 4 5**
13. … have you found it difficult to stay awake on the job in the last week	**1 2 3 4 5**
14. … if you could find a job with comparable pay, would you quit this job	**1 2 3 4 5**
15. … did you experience "nodding off" during your last trip	**1 2 3 4 5**
16. … are you satisfied with your work schedule	**1 2 3 4 5**
17. On average, how many cigarettes do you smoke per week?	
18. On average, how many units of alcohol do you consume per week? (e.g. 1 unit = 1 beer or 1 glass of wine or 1 measure of spirit)	
19. How many cups of caffeinated coffee/ tea/cola do you consume each day?	
20. Do you think you are overweight?	Yes No
21. If yes, how many pounds are you over your ideal weight?	Yes No
22. Do you have trouble getting enough sleep?	Yes No
23. Do you snore?	Yes No
24. Has your spouse or partner complained of your snoring?	Yes No
25. Do you have high blood pressure?	Yes No
26. Are you on medication for high blood pressure?	Yes No
27. Do you have trouble FALLING asleep?	Yes No
28. Do you have trouble STAYING asleep?	Yes No
29. Has your snoring awakened your spouse/partner from sleep?	Yes No
30. Have you been diagnosed with a sleep disorder?	Yes No
31. Do you have sleep apnea?	Yes No
32. Have you been given a c-pap machine for your sleep apnea?	Yes No
33. Do you get regular exercise?	Yes No
34. Do you have a family history of diabetes?	Yes No
35. Have you been diagnosed with diabetes? (either type I or type II) 36. Do you use INSULIN to control your diabetes?	Yes No Yes No
37. How many times a week do you exercise for 30 minutes or more?	

Please think of your work experience over the past 4 weeks (28 days). Indicate the number of days you spent in each of the following work situations.	Number of days (00-28)
11. Missed an entire work day because of problems with your physical or mental health (include only days missed for your own health)?	
12. Missed an entire work day for any other reason (including vacation)?	
13. Missed part of a work day because of problems with your physical or mental health (include only days missed for your own health)?	
14. Missed part of a work day for any other reason (including vacation)?	

The next questions are about the time you spent during your hours at work in **the past 4 weeks (28 days)**. Using the following scales, circle the number that corresponds to your answer:

0	1	2	3	4
All of the time	Most of the time	Some of the time	A little of the time	None of the time

15. How often did health problems limit the kind or amount of work you could do?	0 1 2 3 4
16. How often was your performance higher than most workers on your job?	0 1 2 3 4
17. How often was your performance lower than most workers on your job?	0 1 2 3 4
18. How often did you do no work at times when you were supposed to be working?	0 1 2 3 4
19. How often did you find yourself not working as carefully as you should?	0 1 2 3 4
20. How often was the quality of your work lower than it should have been?	0 1 2 3 4
21. How often did you not concentrate enough on your work?	0 1 2 3 4

22. **On a scale from 0 to 10, how would you rate the usual performance of MOST WORKERS in a job similar to yours**

Worst Performance										**Top Performance**
0	1	2	3	4	5	6	7	8	9	10

23. **How would you rate YOUR usual job performance over the past year or two**

Worst Performance										**Top Performance**
0	1	2	3	4	5	6	7	8	9	10

24. **How would you rate YOUR overall job performance during the past 4 weeks**

Worst Performance										**Top Performance**
0	1	2	3	4	5	6	7	8	9	10

25. **How would you compare your overall job performance on the days you worked during the past 4 weeks (28 days) with the performance of most other workers who have a similar type of job?**

0	1	2	3	4	5	6
A lot better	Somewh at Better	A little better	Average	A little worse	Somewhat worse	A lot Worse