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ABSTRACT

EFFECTS OF 8 AND 12 HOUR NON-ROTATING SHIFT SCHEDULES FOR SECURITY AND PROTECTIVE SERVICES WORKERS

by
Zuleyha Aydin

Shiftwork is a major feature of working life in today's world. Increasing the workday length is a new trend in alternative work schedules. The features of a shift system operation can have an impact on sleep, alertness, and the well-being of shift workers. The objective of this study is to evaluate security and protective services employees working in non-rotating shift systems of 8- hour and 12-hour schedules. New Jersey Institute of Technology's Public Safety Department staff was studied to examine how non-rotating shift schedules affect sleep, alertness, and wellness under five different work schedules.

A survey instrument, approved by the Institutional Review Board was used to acquire data from the participants (n=39). The survey included 29 questions covering alertness, sleep habits, and wellness factors. The survey data were statistically analyzed using single factor ANOVA to compare a 12 h compressed work schedule to an 8 h regular work schedule. The results of the study strongly support ($p<0.10$) the hypothesis that a decreasing level of alertness, and increasing sleep and health problems are associated with a non-rotating 12 h shift. These findings are similar to those of previous researchers highlighting the negative effects of a 12 h rotating shift on workers.

EFFECTS OF 8 AND 12 HOUR NON-ROTATING SHIFT SCHEDULES FOR SECURITY AND PROTECTIVE SERVICES WORKERS

by
Zuleyha Aydin

A Thesis
Submitted to the Faculty of
New Jersey Institute of Technology
in Partial Fulfillment of the Requirements for the Degree of
Master of Science in Occupational Safety and Health Engineering

Department of Mechanical and Industrial Engineering

December 2017

APPROVAL PAGE

EFFECTS OF 8 AND 12 HOUR NON-ROTATING SHIFT SCHEDULES FOR SECURITY AND PROTECTIVE SERVICES WORKERS

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I dedicate this page especially to my beloved mother Kudret Aydin, my beloved brother Dursun Ali Aydin, my sister Meral Aydin and my brothers Hakki Aydin and Murat Aydin.

ACKNOWLEDGEMENT

I would like to thank my thesis advisor, Dr. Arijit Sengupta, for all his professional guidance, help and support while discussing my plans. To my committee members, Dr. Athanassios Bladikas and Dr. Samuel C. Lieber, thank you for your professional reviews and your continuous support which lead this study to reach a full success.

Special thanks to Mr. Mark J. Cyr, who is the lieutenant of New Jersey Institute of Technology Public Safety Department (NJIT), was a major hand in this study. I thank all staff of the NJIT Public Safety Department and also the graduate studies department. I thank Turkish Petroleum Company and Turkish Ministry of Education for giving that great opportunity to me.

To my loving, self-sacrificing, wonderful mother Kudret Aydin, you are the sultan of my heart. To my beautiful hearted brother Dursun Ali Aydin, thank you for encouraging and supporting me all the time and being a wonderful brother. To my sweetie sister Meral Aydin and my manful brothers Hakki Aydin and Murat Aydin, thank you for believing in me. To my father Mehmet Aydin and my brothers Levent Aydin and Bulent Aydin, my cousin Erhan Sayan who passed away, you are always in my memory and I love you all. To my pretty nieces Irmak Ucar, Sarya Aydin and Oyku Ucar, my handsome nephews Arda Aydin and Tuna Aydin, my brother in law Cihangir Ucar, my best friends Ece & Onur Yilmaz, Turan Aydin, Suzan Acar, Ipek Cilgin, Sudarshan Lathkar, Yogesh Kannan and beautiful-good person Ahmet Turgul thank you all.

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ESD	Enough Sleep Duration
h	Hour
M	Morning
D/d	Day
A	Afternoon
SD	Significant Difference
N/n	Number
Vs	Versus
StDev	Standard Deviation
CI	Confidence Interval
CWS	Compressed Work Schedule
ANOVA	Analysis of Variance
NIOSH	National Institute of Occupational Safety And Health
ATCs	Air Traffic Control Specialists
SSI	The Standard Shiftwork Index
SOS	The Survey of Shiftworkers
NJIT	New Jersey Institute of Technology
IRB	Institutional Review Board
%	Percentage

CHAPTER 1

INTRODUCTION

Shiftwork is the major feature of today's working life across a broad range of occupations. Shiftwork is designed to make use of all 24 hours of each day in order to provide service to be available 24 hour per day, 7 days per week. Definition of shiftwork varies by country; and the U.S. Bureau of Labor Statistic describes shiftwork as a system in which "people who do not start work between 7 a.m. and 9 a.m." (Konz and Jonhson, 2004).

Occupational Safety and Health Administration (OSHA) describes a normal work shift as a work period of no more than eight consecutive hours during the day, five days a week with at least an eight-hour rest. Any shift that has more continuous hours, requires working more consecutive days, or requires working during the evening should be considered extended or unusual (Occupational Safety and Health Administration, 2016).

According to the Bureau of Labor Statistics (2016 a,b) data from 2004, nearly 15 million Americans work full time on the evening shift, night shift, rotating shifts, or other employer arranged irregular schedules. And according to 2010 data of U.S. National Health Interview, almost 19% of adult population work 48 hours or more per week and over 7% worked 60 hours or more (Centers for Disease Control, 2016).

One main reason for shift work is economic. Equipment is being available 168 hour per week which increases utilization. The other main reason for shift work is "social need" for the service such as police departments and hospitals which obviously have to be available 24 hour per day, 7 days per week. But the trend becomes acceptable for other

service operations (restaurants, entertainment, and transportation) also to be available more hours per day (Konz and Jonhson, 2004).

Table 1.1. Full-time Wage and Salary Shift Workers by Reason for Working a Non-daytime Schedule, May 2004

(Percent distribution)

Reason for working a non-daytime schedule	Total Shift Workers	Evening Shift	Night Shift	Rotating Shift	Split shift	Employer-arranged irregular schedule	Other
Number (thousands)…..	14,805	4,736	3,221	2,526	497	3,064	715
Percent…….....	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Better arrangements for family or child care……	8.2	11.0	15.9	1.6	5.8	2.6	4.3
Better pay.....	6.8	7.1	10.1	6.5	6.0	3.5	6.1
Allows time for school...	3.2	6.0	2.5	1.4	3.7	1.5	1.8
Could not get any other job.....	8.1	13.9	8.2	5.5	3.8	3.2	3.2
Nature of the job.....	54.6	37.8	32.8	76.7	70.3	80.4	68.3
Personal preference.....	11.5	15.9	21.0	3.0	5.9	3.6	8.0
Some other reason.....	5.6	6.2	7.0	3.8	3.9	4.6	7.1

Source: Bureau of Labor Statistics, 2005.

NOTE: Data related to the sole or principal job of full-time wage and salary workers, exclude all self-employed persons and include persons who worked a non-daytime schedule.

An estimate based on 14,805,000 respondents, Bureau of Labor Statistics (BLS, 2004), (Table 1.1), reported that although reason for non-daytime schedule was "personal

preference" for 11.5 percent of the respondents and "better arrangements for family or child care" for 8.2 percent, the main reason for working a non-daytime schedule is "the nature of the job" with a 54.6 percentage.

The statistics published by BLS in 2004 (Table 1.2 and Table 1.3) regarding the beginning and ending hours of full-time wage and salary workers showed that the percentage of workers begins their job between 7:30 to 8:29 a.m. is 31.8 percent and end their work between 4:30 to 5:29 p.m. is 27.9 percent. These two groups are by far are the two largest groups, however, this also means that roughly 70 percent of workers do not start or end their workday in the normal time.

Table 1.2 Beginning and Ending Hours (AM): Full-time Wage and Salary Workers

(Numbers in thousands)

Time	Beginning time		Ending time	
	Number of Workers	**Percent**	**Number of Workers**	**Percent**
Total, 16 years and over….	99,778	100.0	99,778	100.0
AM				
12:30 to 1:29.....	136	.1	464	.5
1:30 to 2:29.....	104	.1	325	.3
2:30 to 3:29.....	197	.2	363	.4
3:30 to 4:29.....	487	.5	303	.3
4:30 to 5:29.....	1,686	1.7	360	.4
5:30 to 6:29.....	6,911	6.9	529	.5
5:30 to 5:59.....	958	1.0	88	.1
6:00 to 6:29.....	5,953	6.0	441	.4
6:30 to 7:29.....	19,636	19.7	1,373	1.4
6:30 to 6:59.....	3,488	3.5	202	.2
7:00 to 7:29.....	16,148	16.2	1,171	1.2
7:30 to 8:29.....	31,690	**31.8**	741	.7
7:30 to 7:59.....	9,164	9.2	319	.3
8:00 to 8:29.....	22,526	22.6	422	.4
8:30 to 9:29.....	13,383	13.4	177	.2
8:30 to 8:59.....	6,140	6.2	79	.1
9:00 to 9:29.....	7,243	7.3	98	.1
9:30 to 10:29.....	2,244	2.2	97	.1
10:30 to 11:29.....	645	.6	106	.1
11:30 A.M to 12:29 P.M…..	451	.5	192	.2

Source: Bureau of Labor Statistics, 2005.

NOTE: Data related to the sole or principal job of full-time wage and salary workers and exclude all self-employed persons, regardless of whether or not their businesses were incorporated.

Table 1.3 Beginning and Ending Hours (PM): Full-time Wage and Salary Workers

(Numbers in thousands)

Time	Beginning time		Ending time	
	Number of Workers	**Percent**	**Number of Workers**	**Percent**
PM				
12:30 to 1:29.....	346	.3	492	.5
1:30 to 2:29.....	921	.9	1,796	1.8
2:30 to 3:29.....	1,869	1.9	7,550	7.6
2:30 to 2:59.....	358	.4	2,267	2.3
3:00 to 3:29.....	1,511	1.5	5,282	5.3
3:30 to 4:29.....	1,195	1.2	16,455	16.5
3:30 to 3:59.....	306	.3	6,573	6.6
4:00 to 4:29.....	889	.9	9,882	9.9
4:30 to 5:29.....	543	.5	27,848	**27.9**
4:30 to 4:59.....	158	.2	7,914	7.9
5:00 to 5:29.....	386	.4	19,934	20.0
5:30 to 6:29.....	503	.5	11,644	11.7
5:30 to 5:59.....	95	.1	5,131	5.1
6:00 to 6:29.....	408	.4	6,513	6.5
6:30 to 7:29.....	627	.6	4,511	4.5
7:30 to 8:29.....	488	.5	1,811	1.8
8:30 to 9:29.....	262	.3	954	1.0
9:30 to 10:29.....	513	.5	1,125	1.1
10:30 to 11:29.....	979	1.0	1,856	1.9
11:30 P.M to 12:29 A.M….	330	.3	1,170	1.2
Time varies.....	330	.3	1,170	1.2
Actual time not available.....	1,504	1.5	1,589	1.6

Source: Bureau of Labor Statistics, 2005.

NOTE: Data related to the sole or principal job of full-time wage and salary workers and exclude all self-employed persons, regardless of whether or not their businesses were incorporated.

Although a specific standard has not been set for extended or unusual work shifts, the Extended/Unusual Work Shifts Guide (Occupational Safety and Health Administration, 2016) provides necessary information to employers and workers. It is explained in the guide that extended or unusual work shifts can be more stressful physically, mentally, and emotionally. Non-traditional shifts and extended work hours may result in disruption of the body's regular schedule which causes increased fatigue, stress, and lack of concentration. As a consequence these effects increase the risk of operator error, injuries and/or accidents (Occupational Safety and Health Administration, 2016). Ognianova, Dalbokova and Stanchev (1998) noted that problems from shift work include an impairment of objective and subjective health, disturbed sleep, chronic fatigue and a disturbance of social and family life.

Health studies on shift workers have been reporting a series of physical, psychological and social problems because of the disruption of circadian and social rhythms (Waterhouse et al., 1992). The features of the shift system, i.e., fixed (non-rotating) or rotating, 8 or 12 hours, or day or night shift, have impacts on sleep, performance and wellbeing of shift workers (Smith et al., 1998a) and the impact may vary according to the shift schedules engaged (Takahashi et al., 2008). The "rotating shift" is defined as a term that covers a wide variety of work schedules which means shifts rotate or change according to a set schedule and workers take turns working on all shifts of a particular system (Canadian Center for Occupational Health and Safety, 2017).

Figure 1.1, taken from Barton et al. (1995) shows a theoretical framework, on how shift features may interact with worker health and safety. Shift features may lead to disturbed biological rhythm, disturbed sleep and disturbed social and family life, which

will be modified by an individual or situational difference. Outcomes of these disturbances may cause an acute effect on mood and performance, which over a prolonged time and moderated by coping strategy of the worker, may reach to chronic effects on mental health, which ultimately affect health and safety of the worker.

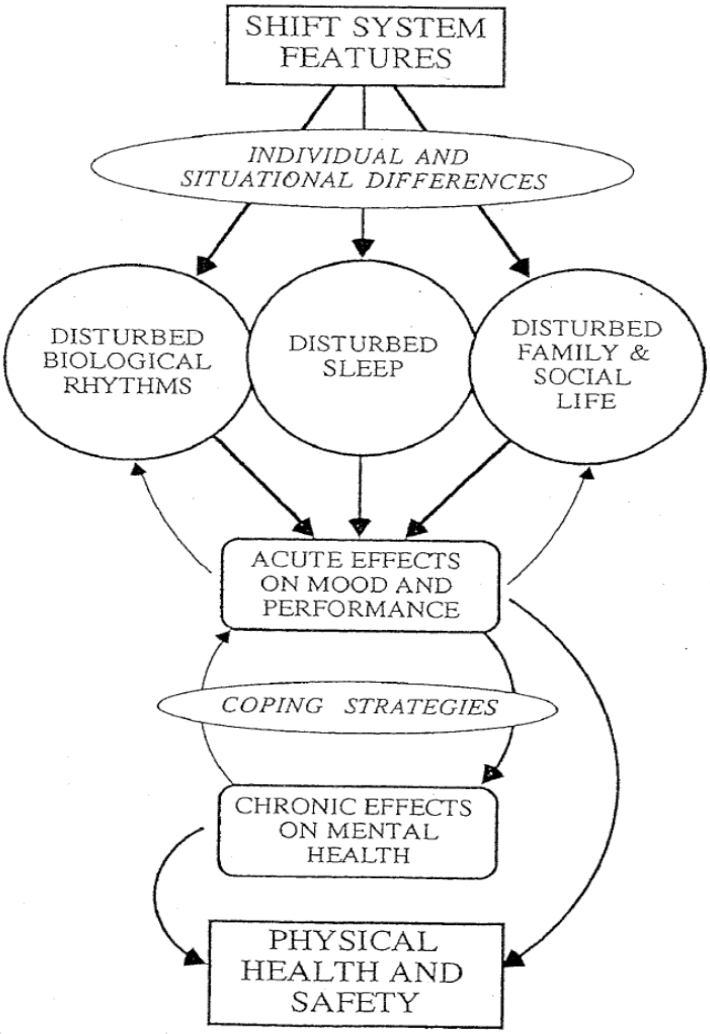

Figure 1.1 A theoretical framework of how shift system features may affect physical health and safety.

Source: Barton, J., Spelten, E., Totterdell, P., Smith, L., Folkard, S., & Costa, G. (1995). The Standard Shiftwork Index: a battery of questionnaires for assessing shiftwork-related problems. Work & Stress, 9(1), 4-30.

1.1 Literature Review

There have been a number of studies (Di Milia, 1998; Akerstedt, 1998; Loudon, 2008) which compared the relative effects of different shift schedules and features (especially comparing the 8 h and 12 h rotating shift systems) on sleep, performance, fatigue, physical and psychological health and social life. The literature review is presented under the following sections; (1) Compressed Work Schedules, (2) Sleep, (3) Performance and Alertness, (4) Attitude, (5) 12 h Shift versus 8 h Shift.

1.1.1 Compressed Work Schedule (CWS)

A "compressed" work schedule (CWS) is broadly defined as a system that employees are required to be at the workplace more than eight hours per day by extending the work day and provide a workweek lasting less than five full days by reducing the number of consecutive days worked in the work week (Tepas, 1985; Schroeder, Rosa and Witt, 1998). In other words, any work week, generally 40 hours, that is completed in four or fewer days by employees. Typical arrangements of these compressed work schedules have work periods of 10 to 12 h per day, four or fewer times per week, with the remaining days off (Paley, Price and Tepas, 1998). Concerns about the possible effects of compressed work schedule on safety, productivity, and fatigue and job efficiency and also associated concerns about health and safety have been raised (Schroeder, Rosa and Witt, 1998).

The researches for the CWS (usually called "Compressed Work Week") reports positive and negative outcomes. Work arrangements of 12 h shifts can lead to eliminate or reduce some shift work problems because workers are required to work fewer days each week which also means fewer night shifts when compared to the 8 h shifts. Thus,

this provides fewer circadian changes on the body and more free time for social life (Smith et al., 1998b). The reduction in night shifts is one of the most important potential benefits of 12 h shifts because of less disruption to sleep, and less conflict with the internal timing mechanism, which are the potential causes of health problems and fatigue in shift workers (Akerstedt, 1998). Also, many studies have reported that compressed work schedules are popular with workers because of providing longer periods of non-work days (Di Milia, 1998; Paley, Price and Tepas, 1998). Di Milia (1998) performed a study on 12 male electricians working in a coal mine by replacing the traditional three 8 h morning/afternoon/night rotating work schedule with a 12 h day/night rotating compressed work schedule by collecting data over five time periods covering 11 months. The results support that CWS was preferred to the previous system by the shift workers.

However, according to Wilson and Rose (1978), the long breaks between work periods of 12 h schedules are defined as a potential source of serious difficulties. Wilson and Rose (1978) examined the petroleum and chemical industries of the United States and Canada by visiting fifty plants; and stated that rest days of some 12 h schedules ranged from 2 to 8 days whereas the former 8 h schedules have much shorter (maximum 3 days away) and less frequent time away from the plant. Some 8 h shift systems' workers could be required 21 out of 28 days at work while the majority of 12 h shift systems require only 14 out of 28 days. This creates a need for heavier reliance on written communications for 12 h shift schedules because the efficient transfer of plant or process status information can create problems after long breaks. Also, a breakdown in communications between shift workers and management or administrators can be another difficulty after 3 or 4 days away from work as well as "forgetting factor".

Tepas (1985) identified a number of advantages and disadvantages of compressed work schedules. Some of the listed advantages are; (a) Increased possibility of larger blocks of rest days for leisure and personal activity, (b) Less night work, (c) Better opportunities to hire skilled workers in tight labor markets, (d) Fewer work days with no loss of pay, (e) A regular, steady work week, (f) More time for scheduling meetings or training sessions, (g) Increased production rates, and (h) Improvement in the quantity or quality of services to the public. Some of the listed disadvantages are; (a) Decrements in job performance due to "moonlighting", (b) Overtime pay required by law, (c) More fatigued shift workers, (d) Little recognition of employees' individual differences, (e) Increases on tardiness rates, (f) Increased exposure to toxic substances and/or physical hazards, (g) Difficulty in scheduling childcare and family life during the workweek, (h) Increased in absenteeism rates.

1.1.2 Sleep

It has been established that shiftwork affects sleep/wakefulness, and may increase the risk of certain health problems (Akersted, 2003). Increased appetite, weight, blood pressure and decreased glucose tolerance or immune response, resulting in development of cardiovascular or immunological disorders have been linked with sleep habits (Fárková et al., 2016). Reduced or disturbed sleep is a common negative consequence of any occupation that has shift work system because of the disruption of the circadian rhythms (Takahashi et al., 2008). The National Sleep Foundation describes circadian rhythms (also known as one's sleep/wake cycle or body clock) as a natural, internal system that's designed to regulate feelings of sleepiness and wakefulness over a 24 hour period. Circadian rhythms are rhythmically repeating and genetically encoded changes in

organisms that are bound to changes in light/dark cycle. Individual sleep-wake cycle, food intake, and other processes are controlled by circadian rhythms. Long-term changes in the duration of sleep, exposition to artificial light after sunset, shift-work schedule and eating habits cause circadian rhythms disruption (Fárková et al., 2016). Sleep disturbances are associated with physical and mental health, chronic fatigue and age (Ognianova, Dalbokova and Stanchev, 1998).

Takahashi et al. (2008) examined how work schedules disturb the sleep of nursing home caregivers (n=775) on four types of work schedules which are; a rotating two-shift system (n=365), a rotating three-shift system (n=66) and other types of shifts (n=78) with a non-shift group included 222 caregivers by conducting a questionnaire that also includes questions about working conditions, health, demographic factors, and lifestyle. Almost 90% of three groups of shifts reported working at night. The differences between the groups were tested by using analysis of variance (ANOVA). The rotating two-shift nursing caregivers at home showed the highest level of sleep problems; with 37.6 % having difficulty initiating sleep, 43.3% with insomnia symptoms and 24.9 % poor sleep quality. In addition, it was reported that the two shift caregivers had more frequent sleep problems if they work night shifts five or more times per month. It was advised that in order to ensure higher levels of health and safety, work schedules need to be designed in an appropriate manner by involving adequate rest breaks during the shift, decreasing the duration of night shift or minimizing the workload of the night shift.

In another study (Paley, Price and Tepas, 1998), impacts of compressed work schedules on the sleep and fatigue of shift workers were evaluated by changing the traditional three-shift (8 h morning/afternoon/night), slow rotating shift schedule of

firefighters at a northeastern US public university (n=24) to a fast rotating compressed work schedule. The new compressed schedule consisted of two 10 h day shifts rotated to two 14 h night shifts followed by 4 non-work days by providing 24 h non-work time during the changeover from day to night shift. All participants were male, and the participants had the opportunity to sleep at the station. Data collection started seven months before the schedule change and continued sixteen months after the schedule change. Data for sleep, sleepiness and mood were collected on three times on the day shift (beginning, middle and end of the 10 h work period) and on four times on the night shifts (beginning and end of 14 h work period and once before going to sleep and once upon awakening) by using daily logs and were analyzed using repeated measures ANOVA. The results showed that there is no significant difference for subjective measures sleepiness and mood between the compressed and non-compressed work schedules. However, sleep length increased 55.0 minutes between the first day and last day on the initial (non-compressed) schedule and decreased 73.3 minutes when firefighters worked with the new (compressed) schedule. It was found that sleep length of the compressed day shift workers was significantly longer than on the compressed night shift, ($p<0.01$). Furthermore, it was indicated that the compressed schedule produces a sleep debt on the night shift compared to the day shift even the firefighters have the luxury opportunity to sleep at the station which made the 14 h night shift acceptable. Thus, the study supported faster shift rotation because of fewer consecutive night shifts. According to the results; it was found that fatigue increased over the course of extended work days but "remained within acceptable limits" which was also stated by Volle et al., (1979).

Longer work shifts decrease the time available for sleep and may lead to increase of fatigue. However, compressed work schedules are popular with workers because of more free time periods. Also, a CWS with a faster rate of rotation between shifts limit exposure to night shift work and may eliminate any cumulative effects (Paley, Price and Tepas, 1998). But there is obviously a sleep problem if the night shift is required. If people work a permanent (non-rotating) night shift and only if they follow the same schedule on days off as works days, it can be possible for them to adjust their circadian rhythm in about 20 days (Konz and Jonhson, 2004).

1.1.3 Performance and Alertness

Some studies have looked into the compressed work schedules effects on performance and alertness. Performance can be affected by the length of the work shift and the nature of the work task (Bonnett, 1990). Ong and Kogi, (1991) reviewed studies on shift work in countries of Asia and South America and reported that 12 h shifts in Singapore were abandoned within one year by several industries because of a decrease in productivity, worker complaints about tiredness and difficulty in concentrating, and an increase in moonlighting.

A vast majority of studies involve comparisons of 8 h and 12 h shift schedules. In an exception, Schroeder, Rosa and Witt (1998), compared a 10 h four-day rotating shift schedule effects on performance and alertness with the traditional 8 h five days rotating shift schedule from a group of 52 Air Traffic Control Specialists (ATCSs). Of the group, 26 ATCSs working on 8 h rotating shift schedule and 26 on the 10 h rotating compressed shift schedule completed the sessions required for the study by participating NIOSH (National Institute of Occupational Safety And Health) fatigue test battery and additional

tests involving self-report measures of alertness. The effects of shift schedules and their interactions were tested with ANOVA. It was reported that air traffic control specialists (ATCs) working on the 10 h shift schedule did not display any evidence of lower performance than the ATCs on an 8 h rotating schedule when comparing the initial four days of the work week. In addition, the ATCs participated in the study reported a consistent decline in sleep time between the days from start to the end of work week. Negative impacts on work performance, safety or overall well-being are not documented as a significant evidence ($p < 0.05$). Interestingly, Peacock et al. (1983) found that police officers on 12 h vs 8 h work schedule improved subjective alertness, sleep, and cardiovascular fitness as opposed to the other studies (Ong and Kogi, 1991; Paley, Price and Tepas, 1998; Schroeder, Rosa and Witt, 1998).

It is generally believed that society is oriented toward traditional daytime work hours and work at night builds up fatigue and reduce alertness (Occupational Safety and Health Administration, 2016). Ognianova, Dalbokova and Stanchev (1998) performed a study on twenty-two male operators from a thermoelectric power station in Bulgaria with the intention of investigating the 12 h day/night shift work effects on changes in alertness and stress states with the individual differences of personal outcomes as modifiers. The 12 h shift system comprised an 8-day cycle of two shifts (12 h day/night) with two successive days of the same shift followed by two days off. The Standard Shiftwork Index (SSI) was developed by a group of shiftwork researchers (Barton et al., 1995), which comprises of a standardized battery of questionnaires. The selected part of the SSI was used in this study with a two-way repeated-measure ANOVA. Results from the study found a significant decrease of the mean alertness level from day to night shift

$F(2, 38) = 3.424$, ($p<0.05$) and the decrease both in first and second nights is higher than the day shift. On the contrary, workload during the day shift reported as significantly greater than the night shift. Despite reduced alertness, it was concluded that efficiency and reliability would not affect by 12 h night shifts. No significant differences found in the stress states between the two successive night shifts which showed that personal outcomes of the operators are able to cope with the shift work. Furthermore, investigated operators preferred the existing 12 h shift system because of having more rest time.

1.1.4 Attitude

The shift workers attitude to the shift system is also important. The negative consequences can be eliminated and the attitude to work hours should be improved by participating shift workers in the design of the shift system (Kecklund, Eriksen and Åkerstedt, 2008).

Kecklund, Eriksen and Åkerstedt (2008) surveyed police officers attitude to six new shift systems by distributing a questionnaire to a random sample of 200 employees within the Swedish police force. The six new systems consisting of three compressed shift systems, a rapidly rotating shift system (a worker changes shifts more than once a week), a slowly rotating shift system (a worker changes shifts less than once a week) and a two shift (12 h day/night) system with no night work and weekends off. It is found that among six new shift systems, the most popular shift system was a forward (when a subsequent shift starts later) rapidly rotating schedule with at least 16 h of rest between shifts and has only one quick return even it has two days less off when compared with the most popular compressed shift systems. The result showed that shift workers do not only prefer compressed shift systems with many consecutive days off because the compressed

shift systems with rapid rotation, frequent quick returns with the highest number of days off got significantly lower ratings.

Age factor had an effect on the attitude towards shift systems. Younger officers showed more a positive attitude to the rapidly rotating compressed shift system (Kecklund, Eriksen and Åkerstedt, 2008).

1.1.5 Comparing 8 h and 12 h Shift Systems

Loudoun (2008) examined whether or not 8 h and 12 h shifts have a differential impact on work/non-work conflict by changing the 8 h shift system of machine operators (n=186) from two processing plants to 12 h shift system. Work/non-work conflict defined as the emotional and behavioral demands of work and non-work life roles. The study duration was 13 months, and the study used three groups of workers; Group A, Group B and Groups C acted as a control group for Group A; performing the same tasks at the same workplace. Data on work/non-work collected on a five-point scale ranging from "1-completely false" to "5-completely true" and consisting of five items about shiftwork effects on social, family and leisure activities. And the General Health Questionnaire (Goldberg, 1972) used for subjective health data. The results of the questionnaire study indicated that there is no positive or negative effect of shift length on work/non-work conflict. 12 h shifts had different problems and different benefits when compared with 8 h shifts. It was reported that work/non-work conflict was positively associated with the psychological health of 8 h and 12 h shift workers rather than the physical health.

Smith et al. (1998b) investigated the impact of changing the 8 h shift schedule of police officers to 12 h shift schedule by using four locations. The change was implemented only at two locations (2 Trial groups, n= 48) and the other two locations

were used as control groups with no change (2 Control groups, n= 44). The Survey of Shiftworkers (SOS) (Folkard et al., 1993) was developed based on the Standard Shiftwork Index (SSI) questionnaire (Barton e al., 1995). It was found that when compared to the original 8 h system, the change in the duration of shifts did not show any statistically significant result (Smith et al., 1998b).

However, sleep, alertness, psychological well-being and satisfaction with shift schedule showed differences between the two trial 12 h systems after six months period due to the implementation of 12 h shift systems. Because at one trial site a flexible 12 h shift system used where officers had the opportunity to attend to non-work responsibilities, to alter duty times more easily and had a late started morning shift while the other trial site practiced a rigid 12 h shift system. Although day shifts sleep length increased significantly ($p<0.05$) at both sites, sleep quality decreased where the rigid 12 h shift system implemented while increased with the flexible 12 h shift system. Alertness of flexible 12 h shift workers did not affect but alertness of shift workers on rigid 12 h schedule decreased. Night shift duration when compared with 8 h nights reported as slightly less sleep around night duty for flexible 12 h system and longer than on 8 h nights for those on the rigid 12 h system. Interestingly, night shift alertness of the flexible system improved. It is reported that satisfaction with 12 h flexible system was greater than both satisfaction with the 8 h system and the rigid 12 h system (Smith et al., 1998b).

Effect of changing from 8 h weekly rotating shift to a rapidly rotating compressed work week utilizing 12 h shift on total sleep time of 12 male electricians in a coal mine was investigated by Di Milia (1998). Self-report diaries were used for data collection, and only three participants completed sleep data for the study during 11 months. ANOVA

results showed that the amount of total sleep time across the time periods did not show a statistically significant difference ($p= 0.84$). However, sleep length of shift workers decreased significantly after the implementation of compressed 12 h shift system as compared to the previous 8 h shift system.

Also, the distribution of sleep for night shift and rostered days off changed quite dramatically ($p<0.05$) and sleep on rostered days off has consistently higher value than the 8 h value. After 8 months, the sleep value of rostered days off decreased as an adaptation response while 12 h night shifts showed a sustained reduction in sleep duration. Although the faster rotation of 12 h shift causes a significant decrease in night shift sleep, the CWS was preferred by workers instead of 8 h system. The study demonstrated that to provide the desired schedule in considering the need for sleep, a slow rotating compressed work schedule with fewer night shifts can be conceivable (Di Milia, 1998).

Although there are considerable concerns about the deleterious effects of working long periods of time on the workers, it seems that implementations of CWS have been increasing (Duchon and Smith, 1993). Twelve hour shift systems are becoming popular (Smith et al., 1998a) because the compressed work week offered by 12 h systems provides larger blocks of time-off for family and leisure activities; however, a strong argument is that longer work shifts especially at night, have the potential of greater risk to safety because of increasing fatigue and disturbing alertness and performance rhythms (Folkard, 1990). Kundi et al. (1995) found that greater need for recovery under 12 h shifts causes a negative impact on leisure and family life and erodes free time during rest breaks. Even the adoption of 12 h shift is such a case (Smith et al., 1998b); a big majority

of employees favored the 12 h shift schedule rather than 8 h shift schedule (Di Milia, 1998; Paley, Price and Tepas., 1998 and Smith et al., 1998b).

1.2 Objective of the Study

There have been a number of studies (Di Milia, 1998; Akerstedt, 1998; Loudon, 2008) and reviews of shift systems but nearly all of them compared the effects of 8 h and 12 h rotating shift schedules by changing from 8 h shift schedule to 12 h shift schedule. However, non-rotating shift effects were not addressed in those studies. There is a lack of data is available with respect to the non-rotating shift system contrast to rotating shift systems.

In addition, the majority of shift work studies have been carried out in health services (Takahashi et al., 2008), nuclear energy plants (Ognianova, Dalbokova and Stanchev, 1998) and transportation industry (Schroeder, Rosa and Witt, 1998). Security and protective services are one of the populations that have received less attention (Kecklund, Eriksen and Akersted, 2008).

The objective of this study is to evaluate effects on security and protective services workers under 8 h and 12 h non-rotating shift. In this study, the participants will be selected from New Jersey Institute of Technology (NJIT) Public Safety Department staffs. The main aim of this study is to determine whether or not non-rotating shift schedule impacts are different from a rotating one by examining 8 h and 12 h non-rotating shift schedules effects on sleep problems and alertness. At the same time, determination of physical health and satisfaction of workers with their work schedules

under different shift systems are the other parts of this present study. The main elements of this study will include:

1. To develop a survey questionnaire and conduct the survey to measure non-rotating shift system effects on sleep, alertness, physical health and satisfaction under different shift schedule types.
2. Analyze the results of non-rotating 8, 10 and 12 h shift schedules and compare the results with the reviewed rotating systems' results that have been done by other studies.

The research results will make a contribution to understanding the effects of non-rotating shift work on security and protective services personnel and help in improving scheduling shiftwork for them.

CHAPTER 2

METHODOLOGY

2.1 Participants and Study Design

The security staff and police officers from Public Safety Department of New Jersey Institute of Technology (NJIT) participated in this questionnaire survey study. The questionnaire survey and the study design were approved by both the Institutional Review Board (IRB) of NJIT and the chief of Public Safety Department. An approved multi questionnaire survey including a consent form was distributed to the shift workers on different days. Participation was voluntary, and all participants were guaranteed confidentially and anonymity. Volunteer participants signed the informed consent form prior to participating in the survey. All participants were an adult and English speaking persons whose ages mainly ranged between 18 and 50.

The department uses three different shift types 8 h (morning, afternoon, evening), 10 h (day, night) and 12 h (day, night). The shift schedules are non-rotating, i.e., the personnel in a shift does not change shift schedule. Job role profiles of the shift workers participated in the survey are; sergeant, police officer, security staff and others (as dispatchers, lieutenant, chief of police and public safety officer) with a percentage of 16%, 22%, 43% and 19%, respectively of 78 total number of staff in the department. All participants were employed in shift system, so the broad task characteristics of their jobs were very similar.

2.2 Survey Questionnaire

This study was designed to examine how extended shift work in non-rotating shift schedule affects shift workers alertness, sleep, and wellness. Based on previous research studies (Smith et al., 1998, Takahashi et al. 2008) involving shift schedule effect on workers, a detailed questionnaire survey was designed. The Survey of Shiftworkers (SOS) (Folkard et al., 1993) which is based on the Standard Shiftwork Index (Barton et al., 1995), utilized in this study. This survey has also been used in previous studies to analyze shift effects on workers (Smith et al., 1998b; Ognianova, Dalbakova and Stanchev, 1998).

The questionnaire survey (See Appendix A) contained three main parts; (i) demographic, (ii) alertness and sleep; and (iii) physical health and satisfaction with shift schedule. The demographic part included 10 questions (age, gender, marital status, number of dependents, etc.) where questions were a mix of multiple choice and short answer type. The second part of the questionnaire consists of 5 questions on alertness and workload; and 17 questions on sleep habit and sleep quality. Participant provided their rating on a numerical scale of 1-5 for alertness and workload where "1" being the most positive response through "3" being neutral to "5" being the most negative response. The questions on a numerical scale of 1-4 where "1" being the most positive response to "4" being the most negative response were used for sleep habit and sleep quality questions.

The third part of the questionnaire survey contained 7 physical health, wellness and satisfaction questions. The responses scale between 1-"the most positive response" to 4-"the most negative response". And a numerical scale of 1-5 where "1" being the most positive response through "3" being neutral to "5" being the most negative response is

used for satisfaction with the current schedule question. A blank sheet is provided at the end of the questionnaire for participant comment. Each participant was allowed 30-minute maximum to fill out the survey questionnaire.

2.3 Data Analysis

The raw data from the survey were compiled using Microsoft Excel and later analyzed using a MINITAB15 Statistical Software by conducting a Tukey test as did the reviewed studies (Smith et al., 1998b; Ognianova, Dalbokova and Stanchev, 1998; Loudoun, 2008). The statistical results from the survey have been provided in Appendix B, Appendix C, and Appendix D. The participation from each shift type was varied, in total 39 participants completed and returned the questionnaire survey, with 10 in 8 h morning shift, 12 in 8 h afternoon shift, 3 in 8 h night shift, 8 in 12 h day shift, 4 in 12 h night shift and 2 in 10 h day shift. The overall response rate of the questions by participants was nearly 100% except for gender question that is the second question in the demographic part of the survey. Due to the low participation from 10 h shift, data for 10 h shift system were not included in the analysis.

This study intended to find out any differences existing between 8 h regular and 12 h extended non-rotating shift types as well as non-rotating and rotating shift systems by making a comparison with the other similar studies performed previously.

CHAPTER 3

RESULTS AND ANALYSIS

Participants are aged between 18 and 50 and are predominantly male with a percentage of 74%. The majority of the participants are married/living with a partner (54%) that is followed by single participants with a percentage of 43%, and only one participant is from Separated/Divorced/Widow (3%) category. Participants of 8 h shift workers are police officer, security staff, and others (as dispatchers, lieutenant, chief of police, public safety officer) with a percentage of 8%, 64%, and 28%, respectively; while participants of the 12 h shifts are sergeant (50%) and police officer (50%) at NJIT Public Safety Department. The participant has an average (the standard deviation) of combined present and previous shift experience of 5.68 (SD=0.85) years. Average (the standard deviation) overtime hours per week is 9.75 (SD=9.91). Participants rated their workload between 3 (average) and 5 (extremely heavy). The ratings of workload are not significantly different between any of the groups studied.

The effects on alertness, sleep and wellness have been compared between the groups 8 h shift versus 12 h shift, 8 h morning shift versus 8 h afternoon shift and 8 h morning shift versus 12 h day shift. Effects of 8 h or 12 h night shifts were not compared individually because of low participation. There were only 3 and 4 participants in 8 h and 12 h night shifts. Tukey's test with 90% confidence level was conducted to check the statistical significance of non-rotating shift effects.

3.1 Alertness

Participants rated their overall alertness level in the shift and alertness levels during the Early-stage, Mid-stage and Late-stage of their shifts, in scale 1 to 5, “1” very alert and “5” very sleepy. Figure 3.1 compares these ratings for 8 h versus 12 h shifts and Table 3.1 provides the means and standard deviations of the groups. Consistently the mean rating of alertness levels of 12 h shift workers is lower than 8 h shift workers, for the overall shift and in every stage of the shift. The data also showed that both groups rated decreasing level of alertness from early stage to late stage of the shift. The mean alertness score at the late-stage of the shift for 12 h 2.83 and 8 h 2.16 is worse than both the mid-stage 2.25; 1.64 and the early-stage 2.00; 1.44 of the shift, respectively.

With a significance level of 90%, a significant difference ($p=0.033$) was found in the mean scores of early-stage alertness level between the 8 h and 12 h shifts. Also, a statistically significant difference for the mid-stage alertness level is observed between the shift types ($p=0.052$) as well as for the overall alertness level with a $p= 0.076$. Statistical results and Figure 3.1 indicates that alertness level rated by 12 h shift workers is fairly lower in comparison to the 8 h shift workers.

Although there is no statistically significant difference found for the late-stage alertness level of 8 h and 12 h shifts, Figure 3.1 shows that the scores for both 8 h and 12 h shift workers increased at the late-stage of their shift. Late-stage alertness level scores are higher than the overall and other stages of the shift scores for both shift types which means that workers are feeling less alert more sleepy at the late-stage of the shift.

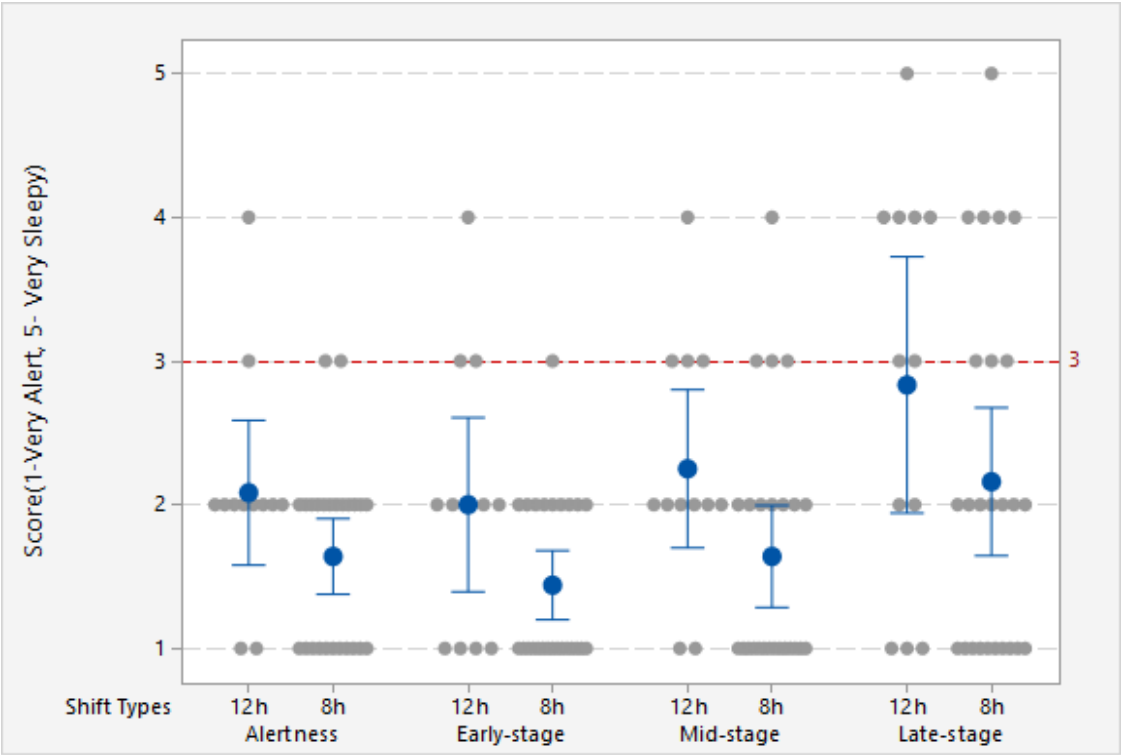

Figure 3.1 Individual Value Plot of alertness ratings in the entire shift and, early, mid-stage and late-stage of shift for 8 h and 12 h shifts with 95% CI for the mean.

Table 3.1 Summary Statistics for Alertness of 8 h and 12 h Shift Types

Variable	Shift Types	N	Mean	StDev
Entire shift	12 h	12	2.08	0.79
	8 h	25	1.64	0.63
Early-stage	12 h	12	2.00	0.95
	8 h	25	1.44	0.58
Mid-stage	12 h	12	2.25	0.86
	8 h	25	1.64	0.86
Late-stage	12 h	12	2.83	1.40
	8 h	25	2.16	1.24

To investigate the effect of the time of the day, alertness ratings of 8 h morning shift (from 07.00 a.m. to 03.00 p.m.) were compared with 8 h afternoon shift (from 03.00 p.m. to 11.00 p.m.). The 8 h night shift data are not included because there are only three participants from that shift. Figure 3.2 and Table 3.2 illustrate this comparison. The mean alertness score of 8 h morning shift almost remained unchanged as the shift progressed, but 8 h afternoon shift the alertness level rated to decrease gradually as the shift progressed. The late-stage mean alertness level score of 8 h afternoon shift 2.5 is higher than the 8 h morning shift 1.6 and the difference of mean is statistically significant (p=0.088). The data strongly support that the 8 h afternoon shift workers felt less alert at the late-stage of the shift than the 8 h morning shift workers.

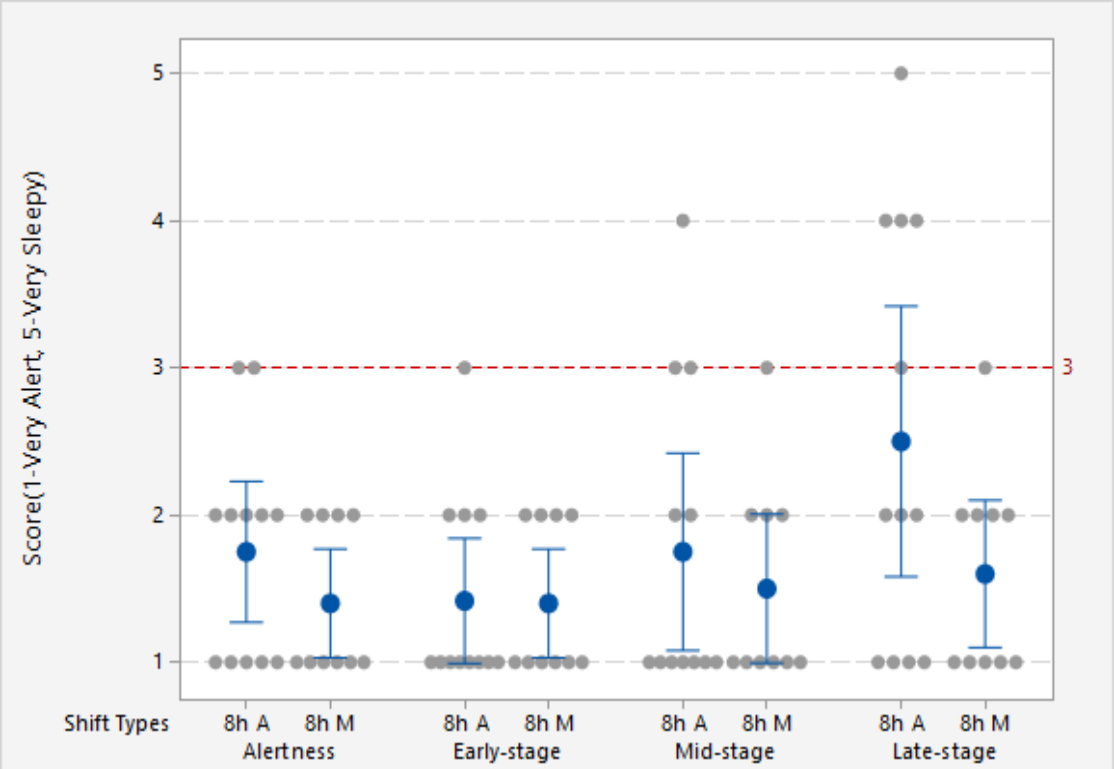

Figure 3.2 Individual Value Plot of alertness level and alertness levels of 8 h Morning and 8 h Afternoon shifts during the three stages (Early, Mid-stage and Late-stage) of the shift with 95% CI for the mean.

Table 3.2 Summary Statistics for Alertness of 8 h Morning and 8 h Afternoon Shifts

Variable	Shifts	N	Mean	StDev
Entire shift	8 h A	12	1.75	0.75
	8 h M	10	1.40	0.51
Early-stage	8 h A	12	1.41	0.66
	8 h M	10	1.40	0.51
Mid-stage	8 h A	12	1.75	1.05
	8 h M	10	1.50	0.70
Late-stage	8 h A	12	2.50	1.44
	8 h M	10	1.60	0.69

8 h morning (from 07.00 a.m. to 03.00 p.m.) and 12 h day (from 07.00 a.m. to 07.00 p.m.) shifts data are compared with an objective to find the effect of length of shift on alertness. Both shifts started at 7 a.m., but the 12 h day shift extends to 7 p.m. Figure 3.3 and Table 3.3 show that the mean alertness scores of these two groups. The 12 h day shift was consistently showed lesser alertness level compared to 8 h morning. A statistically significant difference ($p=0.037$) was found for early-stage mean alertness level between the 8 h morning 1.4 and 12 h day 2.25 shifts. Similar to the results for 12 h vs 8 h shifts, this result of 12 h day to 8 h morning also supports that the extended shift has a detrimental effect on alertness.

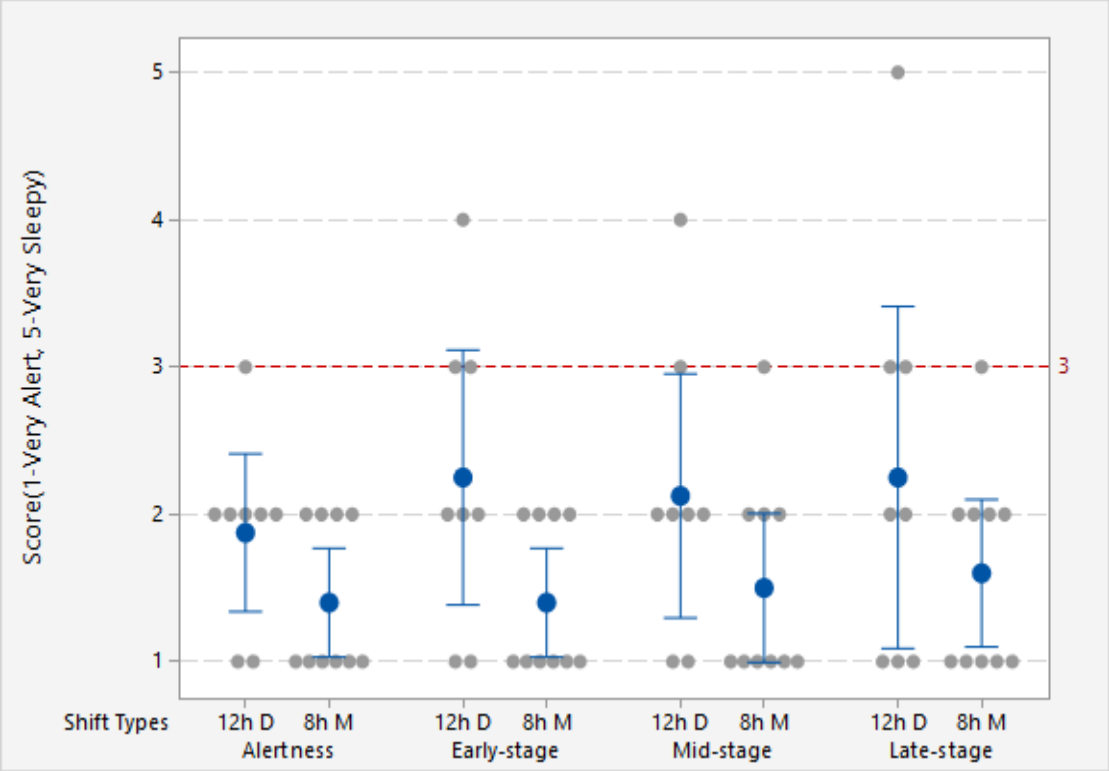

Figure 3.3 Individual Value Plot of alertness level and alertness levels of 8 h Morning and 12 h Day shifts during the three stages (Early, Mid-stage and Late-stage) of the shift with 95% CI for the mean.

Table 3.3 Summary Statistics for Alertness of 8 h Morning and 12 h Day Shifts

Variable	Shift Types	N	Mean	StDev
Entire shift	12 h D	8	1.87	0.64
	8 h M	10	1.40	0.51
Early-stage	12 h D	8	2.25	1.03
	8 h M	10	1.40	0.51
Mid-stage	12 h D	8	2.12	0.99
	8 h M	10	1.50	0.70
Late-stage	12 h D	8	2.25	1.38
	8 h M	10	1.60	0.69

3.2 Sleep Duration, Sleep Problem and Sleep Quality

3.2.1 Sleep Duration

The “amount of sleep needed” reported by the 8 h and 12 h shifts participants are 6.96 and 6.58 hours per day, respectively, and the difference in means is not significant. However, the reported “amount of sleep duration they get" per day, was significantly ($p=0.023$) less for 12 h shift compared to 8 h shift. Figure 3.4 and Table 3.4 provide the plot and summary statistics of “Duration of sleep the participants get”. The scale used is “1” less than 6 hours per day,”2” between 6 and 8 hours per day and “3” over 8 hours per day. The mean score of sleep duration per day for 8 h shift workers is higher than the 12 h shift workers as demonstrated in Figure 3.4. Also, there is no individual from 12 h shift system who chose the amount of sleep duration as over 8 hours per day. The mean duration of sleep for 8 h morning shift and 8 h afternoon shift, are rated nearly identical, 1.9 and 2, respectively. Whereas, for 12 h day shift, the rating was 1.5, lower than 8 h morning shift. These results indicate that sleep duration is affected by longer shift duration and effect of working in the afternoon and evening did not affect the sleep duration, although they worked until 11 p.m.

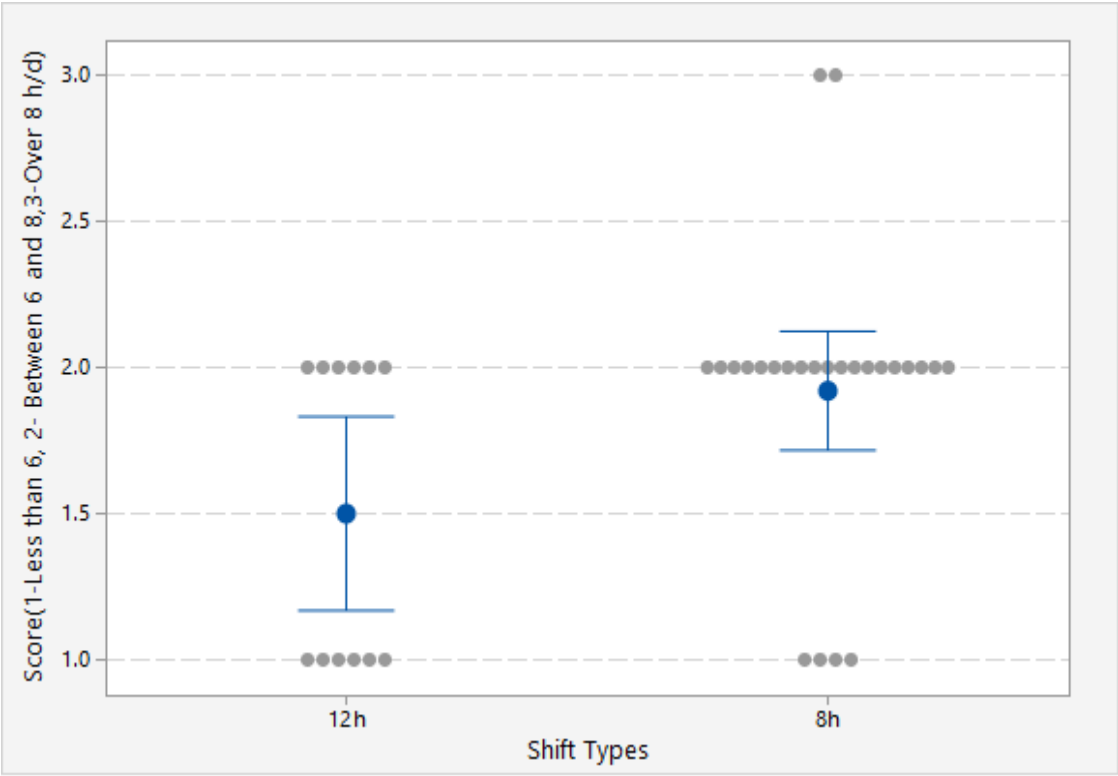

Figure 3.4 Individual Value Plot of the amount of sleep duration with 95% CI for the mean according to the 8 h and 12 h shift types.

Table 3.4 Summary Statistics of Amount of Sleep Duration for 8 h and 12 h Shift Types

Shift Types	N	Mean	StDev
12 h	12	1.50	0.52
8 h	25	1.92	0.49

3.2.2 Sleep Problems

Sleep problems included 11 questions and participants chose 1 (Almost Never), 2 (Quite Seldom), 3 (Quite Often) and 4 (Almost Always) to express how often they experience these sleep problems.

Mean sleep problem indicators were compared for 8 h and 12 h sifts, and there is a statistically significant difference observed for two sleep problems (Figure 3.5, Table 3.5). The rating for the question "Do you feel any sleep insufficiency?" was averaged at 1.36 for 8 h shift, and 1.82 for 12 h shift and the difference is significant at p=0.088. The second question was "How often does your shift type affect sleep negatively?" was averaged at 1.36 and 2.00 for 8 h and 12 h shift respectively, reached a statistical significance of p = 0.037. These results support the hypothesis that extended shift is associated with increased level of sleep problems.

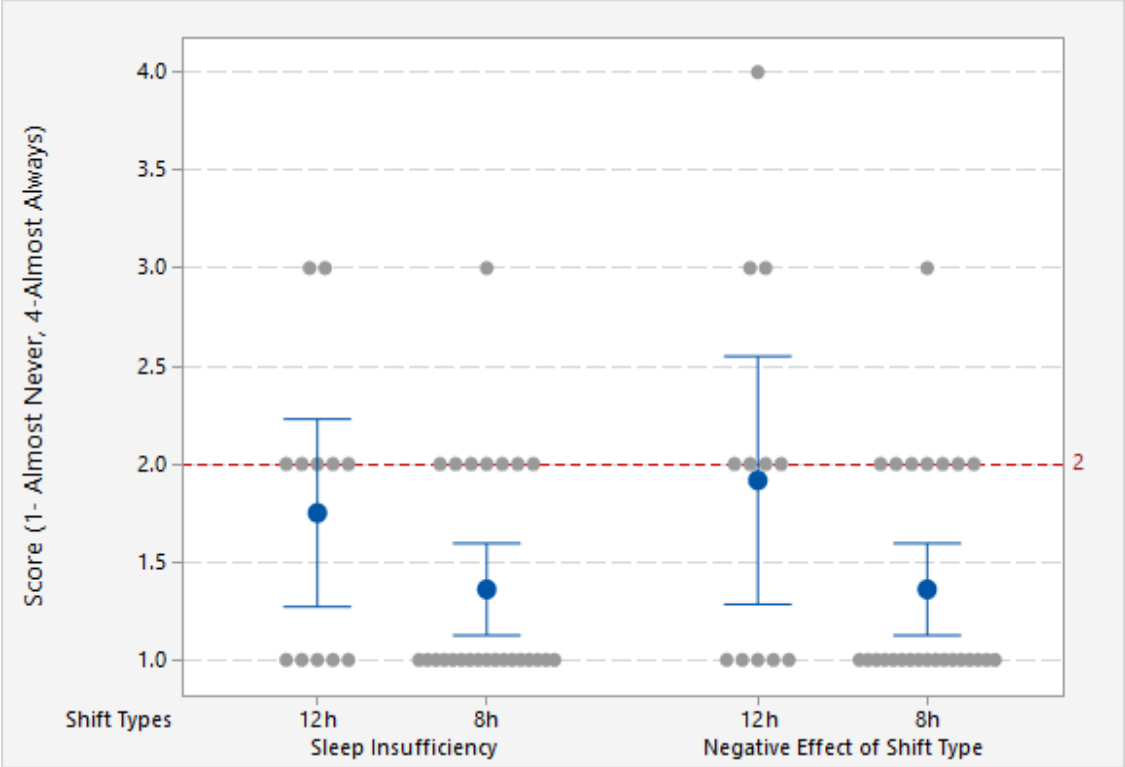

Figure 3.5 Individual Value Plot of sleep habit indicators with 95% CI for the mean according to the 8 h and 12 h shift types.

Table 3.5 Summary Statistics of Sleep Habit Indicators for 8 h and 12 h Shift Types

Variable	Shift Types	N	Mean	StDev
Sleep Insufficiency	12 h	12	1.75	0.75
	8 h	25	1.36	0.56
Negative Effect of Shift Type	12 h	12	1.91	0.99
	8 h	25	1.36	0.56

A statistically significant difference (p= 0.017) was observed for "difficulty for initiating sleep" factor between 8 h morning and 8 h afternoon shifts. Figure 3.6 shows that the mean score of 8 h afternoon shift 1.8 is higher than the 8 h morning shift 1.1 which means 8 h afternoon shift workers have difficulty in initiating sleep as compared to the 8 h morning shift workers. It could be related to the disruption of circadian rhythms.

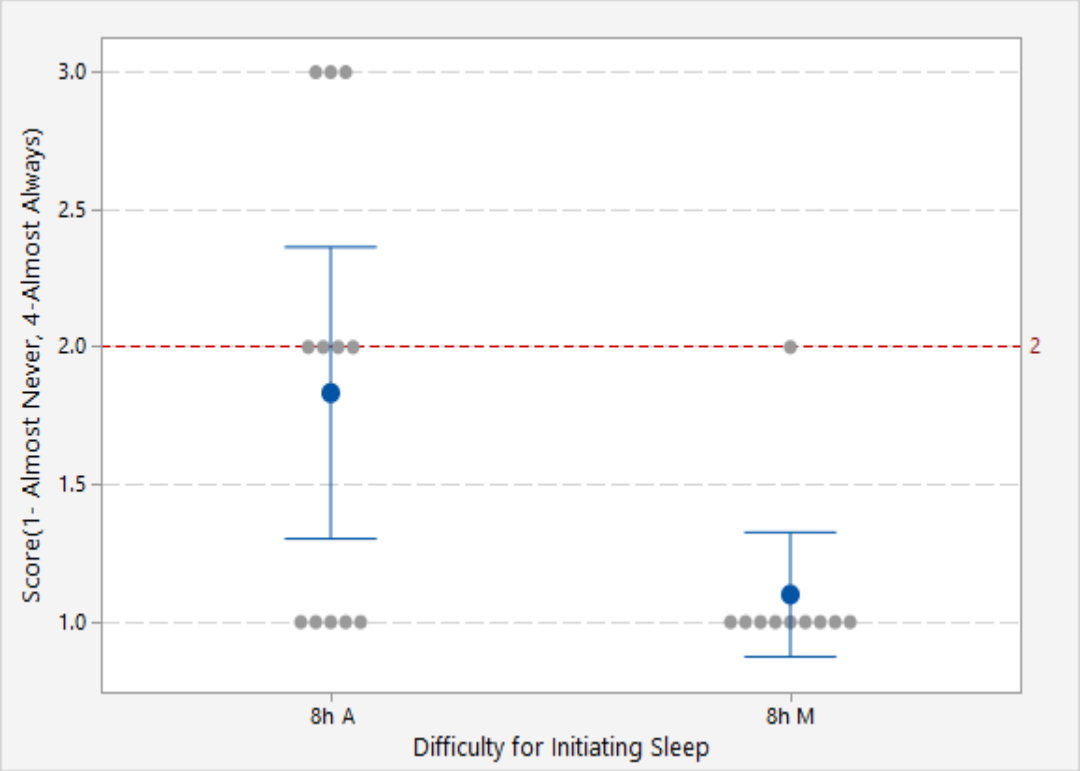

Figure 3.6 Individual Value Plot of difficulty for initiating sleep habit indicator for 8 h Morning and 8 h Afternoon shifts with 95% CI for the mean according to the shift types.

Table 3.6 Summary Statistics of "Difficulty for Initiating Sleep" Indicator for 8 h Morning and 8 h Afternoon Shifts

Shift Types	N	Mean	StDev
8 h A	12	1.83	0.83
8 h M	10	1.10	0.31

When comparing 8 h morning shift with 12 h day shift, the questions "Do you feel any difficulty in initiating sleep?" (p=0.019), "Do you feel any sleep insufficiency?" (p=0.015) and "How often does your shift type affect sleep negatively?" (p=0.082) were statistically significant. Figure 3.7 also shows that 12 h day shift mean scores for these three questions are much higher than 8 h morning shift. Results are strongly indicating

that 12 h day shift workers have more sleep problems than 8 h morning shift even the start time is the same. So this may be related to extended shift hours.

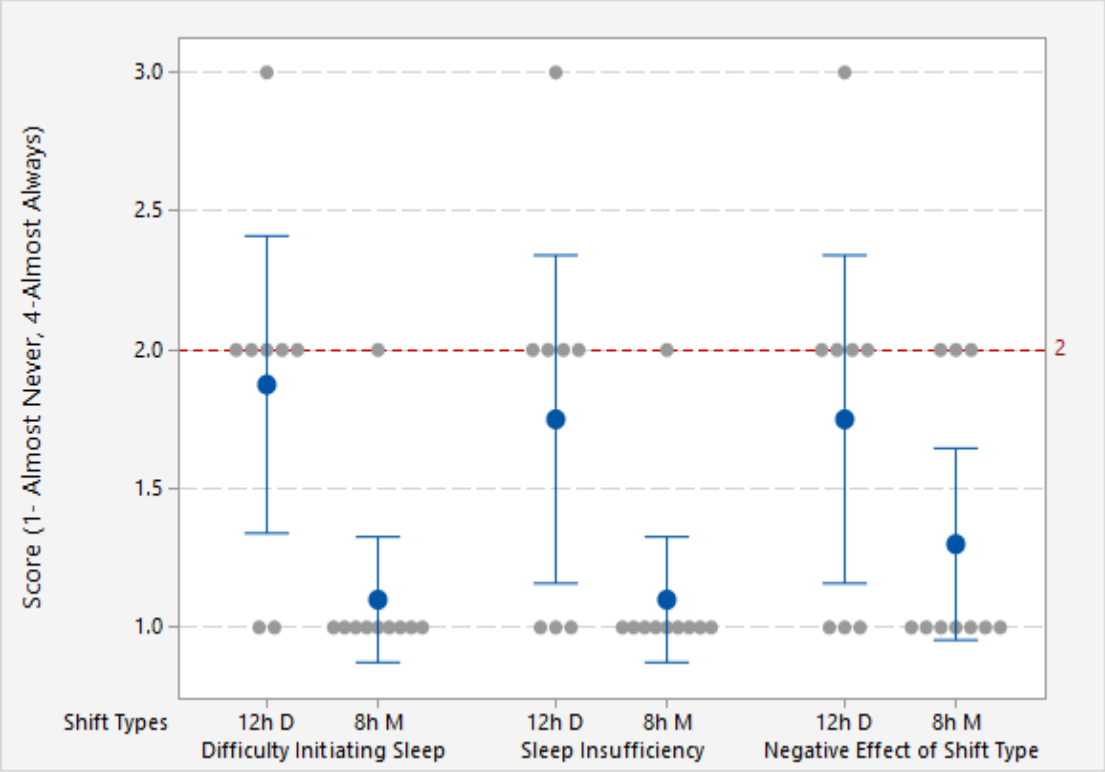

Figure 3.7 Individual Value Plot of sleep habit indicators of 8 h Morning and 12 h Day shifts with 95% CI for the mean.

Table 3.7 Summary Statistics of Sleep Habit Indicators for 8 h Morning and 12 h Day Shifts

Variable	Shift Types	N	Mean	StDev
Difficulty Initiating Sleep	12 h D	8	1.87	0.64
	8 h M	10	1.10	0.31
Sleep Insufficiency	12 h D	8	1.75	0.70
	8 h M	10	1.10	0.31
Negative Effect of Shift Type	12 h D	8	1.75	0.70
	8 h M	10	1.30	0.48

3.2.3 Sleep Quality

The sleep quality was assessed with four questions on a four-point scale: 1-“almost always”, 2 -“quite often”, 3- “quite seldom and 4-“almost never”. Figure 3.8 and Table 3.8 shows that for every sleep quality indicators; 12 h shift mean scores are higher than the 8 h shift, indicating inferior sleep quality for 12 h shift participants. When 8 h morning shift was compared with 12 h day shift, a similar but less pronounced difference of means was found. Although no statistical difference found between sleep quality indicators, sleep quality scores of 8 h shift are better than 12 h shift.

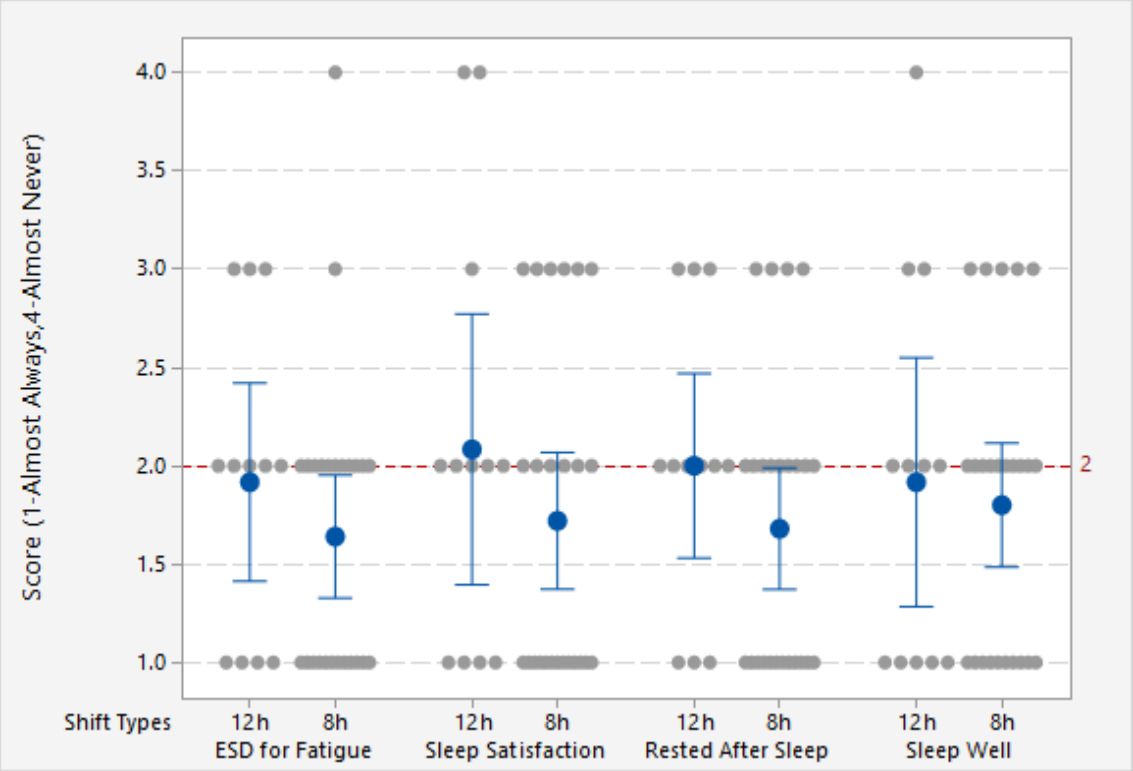

Figure 3.8 Individual Value Plot of sleep quality indicators with 95% CI for the mean according to the 8 h and 12 h shift types.

Table 3.8 Summary Statistics of Sleep Quality Indicators for 8 h and 12 h Shift Types

Variable	Shift Types	N	Mean	StDev
ESD for Fatigue	12 h	12	1.91	0.79
	8 h	25	1.64	0.75
Sleep Satisfaction	12 h	12	2.08	1.08
	8 h	25	1.72	0.84
Rested After Sleep	12 h	12	2.00	0.73
	8 h	25	1.68	0.74
Sleep Well	12 h	12	1.91	0.99
	8 h	25	1.80	0.76

3.3 Physical Health and Satisfaction

Six questions addressed the frequency of pain in various body locations, in a scale 1- “Almost never”, 2- “Sometimes”, 3- “Usually”, and 4-“Almost always”. Surprisingly, a significantly ($p=0.005$) higher mean “back or lower back pain” frequency was reported by the 12 h group (2.66) compared to the 8 h group (1.78). A similar result was also noted when comparing 8 h morning with 12 h day shift. 12 h day shift mean score of 2.37 is higher than 8 h morning shift 1.7, and the difference in mean was statistically significant ($p=0.019$). This result supports the notion that for shift types as “12 h shift workers suffer from back/lower back pain more than 8 h shift workers”.

A statistically significant result ($p=0.043$) was found between 8 h morning and 8 h afternoon for the frequency of “Pain in Arm/Wrist” physical health indicator. The mean score for 8 h morning was 1.3 as opposed to 8 h afternoon was 1.0. This difference was statistically significant but the difference is small, and the mean values are also

small. The seventh question in this section was “How do you rate your health”. There was no significant difference in mean ratings between 8 h and 12 h shifts. Nor there was any difference between 8 h morning and 12 h day or 8 h afternoon shift. The mean ratings tended to be “healthy”.

The last question of the survey was the satisfaction with the current shift schedule. It is assessed on a five-point scale ranging from “very satisfied” (1) through “average” (3) to “very unsatisfied” (5). Mean score for both 8 h (1.67) and 12 h (1.68) shift workers rated their satisfaction between 1-“Very Satisfied” and 2- “Somewhat Satisfied”, and the difference of mean was not statistically significant. The result was similar when comparing 8 h morning (1.3) to 12 h day (1.4) shift, but mean score 8 h afternoon (2.00) was significantly ($p=0.066$) different and shows this group is more dissatisfied with their shift.

3.4 Discussion

A significant decrease in mean alertness level was found for compressed work schedule (CWS) workers (12 h) as compared to normal shift (8 h) workers for early-stage ($p=0.033$), mid-stage ($p=0.052$) and for the overall shift ($p= 0.076$). When comparing 12 h day shift and 8 h morning shift, similar results were gathered ($p=0.037$) for early-stage alertness level. These results strongly indicate that compressed work schedule (CWS) is likely to be associated to decreased level of alertness, which is similar in finding for large number of studies in rotating CWS (Ong and Kogi, 1991; Paley, Price and Tepas, 1998; Smith et al. 1998b; Schroeder, Rosa and Witt, 1998). A dissimilar result was stated by Peacock et al. (1983) as they found that police officers on 12 h vs 8 h work schedule improved subjective alertness. It is found that 8 h morning shift workers alertness level almost not changed but the 8 h afternoon shift workers alertness level decreased gradually, especially at the late-stage of shift ($p=0.088$). The results support that working until late evening, 11 p.m., has a negative effect on alertness.

Di Milia (1998) reported a reduction in sleep duration for 12 h rotating shift workers after changing 8 h rotating shift system to a 12 h rotating shift system. Smith et al. (1998b) noted a decrease in duration and quality of sleep when a rigid 12 h rotating shift system was implemented, as compared to 8 h rotating shift. Takahashi et al. (2008) noted that the rotating two-shift (12 h day/night) nursing caregivers showed the highest level of sleep problems: difficulty initiating sleep, insomnia symptoms, and poor sleep quality. In this study also, non-rotating CWS (12 h) shift workers scored significantly less sleep duration ($p=0.023$) and scored higher in sleep insufficiency ($p=0.088$) and in the negative effect of shift type on sleep ($p=0.037$) compared to normal 8 h shift.

Furthermore, 12 h day shift had more difficulty in initiating sleep (p=0.019), more sleep insufficiency (p=0.015) and scored higher in the negative effect of shift type on sleep (p=0.082) as compared to 8 h morning shift workers. Interestingly, sleep problems scored by 8 h morning were identical to 8 h afternoon shift. This indicates that sleep score is largely affected by longer shift duration of CWS shift system, but working in the afternoon and evening in normal 8 h shift did not affect the sleep duration score. The 8 h afternoon shift felt more difficult (p=0.017) for initiating sleep compared to the 8 h morning, which is possibly related to the disruption of circadian rhythms.

Both 12 h and 8 h shift workers ranked their overall wellness as "healthy". However, among various other wellness factors studied, 12 h shift workers noted significantly (p= 0.005) higher frequency of "back or lower back pain" when compared to 8 h shift workers. A similar result (p=0.019) was found for 12 h day shift was compared to 8 h morning shift. Both results indicate poor wellness for CWS. A small but significantly higher frequency of "pain in arm and wrist" was also noted by the 8 h morning shift workers than 8 h afternoon shift workers. Although non-significant, Kecklund, Eriksen and Åkerstedt (2008) found a positive attitude between health complaints (pain in shoulders, pain in upper/lower back, etc.) of police officers and rapidly rotating shift systems. Non-rotating shift systems may lead more health complaints rather than rotating shift systems. Above effects of shift length or timing factors are somewhat questionable because the type of job responsibility and the age group of the workers were not homogeneously distributed among the different shifts-groups. The effects of non-homogeneity of age and job responsibility among the various shifts should be studied in more details in a future study.

In the majority of the studies (Di Milia, 1998; Paley, Price and Tepas, 1998; and Smith et al., 1998b), CWS was favored by the workers with higher satisfaction score. The non-rotating type CWS workers seem to have a different attitude, and the satisfaction score for 12 h shift type was not any different from that of the 8 h shift type. However, 8 h afternoon workers examined more dissatisfied ($p=0.066$) with their shift schedule compared to 8 h morning shift.

CHAPTER 4

CONCLUSION

The overall objective of this study was to evaluate non-rotating shift system outcomes, specifically; alertness, sleep and wellness outcomes of 8 h and 12 h non-rotating shift types. A survey questionnaire was developed, and n=39 workers out of total 78 personnel from NJIT Public Safety Department participated.

The results of the study strongly support that decreasing level of alertness, and increasing sleep and health problems are associated with 12 h shift. These findings are similar to those of previous researchers highlighting the negative effects of 12 h rotating shift on workers (Wilson and Rose, 1978; Tepas, 1985; Takahashi et al., 2008).

One important limitation of this study was that very few night shift workers participated, and effects of non-rotating night shift for 8 or 12 h could not be investigated. Since our society is generally oriented towards daytime work (OSHA, 2016) effects of non-rotating night shifts should provide important information about non-rotating shift system. This should be investigated in a future study.

Additionally, the advanced statistical analysis could have been performed to separate out the effect of participant age or type of work responsibility to understand the net effect of various shifts. This could not be done due to time limitation.

APPENDIX A

QUESTIONNAIRE SURVEY FORM

Appendix A includes the questionnaire survey that has been conducted.

PART - I

General Demographic Questions

Age: Female/Male (circle one)

Between 18 and 35 years old
Between 35 and 50 years old
Over 50 years old

Are you: Single _____

(Tick one) Married/ Living with a partner _____

Separated/Divorced/Widowed _____

How many dependents live with you (e.g. children, spouse, other)?

None
Between 1-3
Over 3

What is your position at the NJIT Public Safety Department? (Select one)
Sergeant
Police Officer
Security Staff
If other, please specify _____

What is your shift schedule type at the NJIT Public Safety Department? (Select one)
8 hours morning/day shift
8 hours afternoon shift
8 hours night shift
10 hours morning/day shift
10 hours night shift
12 hours morning/day shift
12 hours night shift

What time does your regular shift start?
_____AM / _____PM

How long have you been working on your present shift system?
_____ years

How many overtime hours, on average, do you do per week?
_____ hours

Have you worked on a shift system previously?
Yes
If yes, how long did you work? _____years _____months
No

PART-II

Questions Related to Your Work, Alertness, and Sleep

Please rate your workload.

Extremely Light	Quite Light	Average	Quite Heavy	Extremely Heavy
1	2	3	4	5

Please rate **how alert or sleepy you normally feel** during your shift.

Very Alert	Alert	Neither Alert/ Nor Sleepy	Sleepy	Very Sleepy
1	2	3	4	5

Please rate how alert or sleepy you normally feel **at each stage of your shift** by circling the appropriate numbers.

	Very Alert	Alert	Neither Alert/ Nor Sleepy	Sleepy	Very Sleepy
Early-stage of the shift	1	2	3	4	5
Mid-stage of the shift	1	2	3	4	5
Late-stage of the shift	1	2	3	4	5

How many hours of sleep do you feel you usually need per day?
_____hours

Please select the amount of your sleep duration.
Less than 6 hours/day
Between 6 hours and 8 hours
Over 8 hours/day
Other_____

Please choose the response option which best represents **your usual sleep problems, if any.**

	Almost Never	Quite Seldom	Quite Often	Almost Always
Do you feel any difficulty initiating sleep?	1	2	3	4
Do you feel any difficulty maintaining sleep?	1	2	3	4
Do you ever wake up earlier than you intended?	1	2	3	4
Have you been prescribed any sleeping pills?	1	2	3	4
Do you suffer from sleep-disordered breathing?	1	2	3	4
Do you snore?	1	2	3	4
Do you suffer from sleeplessness?	1	2	3	4
Do you feel any sleep insufficiency?	1	2	3	4
How often do you have poor quality sleep?	1	2	3	4
How often does your shift type affect your sleep negatively?	1	2	3	4
How often working overtime effect y our sleep negatively?	1	2	3	4

Please choose the response option which best represents **your usual way of sleep.**

	Almost Always	Quite Often	Quite Seldom	Almost Never
My sleep duration is enough to recover from fatigue	1	2	3	4
I am satisfied with the amount of sleep I normally get	1	2	3	4
I normally feel rested after sleep	1	2	3	4
I normally sleep well	1	2	3	4

PART-III

Questions Related to Your Health and Satisfaction

Please choose the response option which best represents your usual way of feeling.

Almost never Sometimes Usually Almost always

How often do you suffer from pain in your:

shoulder and/or neck	1	2	3	4
back and/or lower back	1	2	3	4
arm and/or wrist	1	2	3	4
leg and/or knee	1	2	3	4

How often do you suffer from pain, such as:

headaches	1	2	3	4
stomach-aches	1	2	3	4

How do you rate your health?

Extremely Healthy	**Healthy**	**Somewhat Unhealthy**	**Extremely Unhealthy**
1	2	3	4

Please rate how satisfied you are with your shift schedule?

Very Satisfied	**Somewhat Satisfied**	**Neutral**	**Somewhat Unsatisfied**	**Very Unsatisfied**
1	2	3	4	5

If you have any comments or observations relating to your experiences as a shift worker that has not been covered in this questionnaire we would be very grateful if you would describe them in the space below. Thank you!

_____
_____
_____
_____
_____
_____
_____
_____

Thank you for filling out this questionnaire.

APPENDIX B

STATISTICAL TESTS

Appendix B includes statistical analysis of Part I, Part II and Part III of the questionnaire survey for 8 h versus 12 h shift types.

General Linear Model: Part I, Part II and Part III for 8h versus 12h Shift Types

```
Factor        Type   Levels
              Values Shift Types
              fixed  2    12h, 8h
```

PART I

Analysis of Variance for **Age**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.0014	0.0014	0.0014	0.00	0.958
Error	35	18.1067	18.1067	0.5173		
Total	36	18.1081				

S = 0.719259 R-Sq = 0.01% R-Sq(adj) = 0.00%

Analysis of Variance for **Gender**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.0177	0.0177	0.0177	0.14	0.707
Error	35	4.3067	4.3067	0.1230		
Total	36	4.3243				

S = 0.350781 R-Sq = 0.41% R-Sq(adj) = 0.00%

Analysis of Variance for **Marital Status**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.0923	0.0923	0.0923	0.30	0.588
Error	35	10.8267	10.8267	0.3093		
Total	36	10.9189				

S = 0.556177 R-Sq = 0.84% R-Sq(adj) = 0.00%

Analysis of Variance for **Number of Dependents**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	1.0314	1.0314	1.0314	2.11	0.155
Error	35	17.0767	17.0767	0.4879		
Total	36	18.1081				

S = 0.698502 R-Sq = 5.70% R-Sq(adj) = 3.00%

Analysis of Variance for **Position at NJIT Public Safety Department**, using Adjusted SS for
Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	23.432	23.432	23.432	74.56	0.000
Error	35	11.000	11.000	0.314		
Total	36	34.432				

S = 0.560612 R-Sq = 68.05% R-Sq(adj) = 67.14%

Analysis of Variance for **Years of Experience in Present Shift System**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	122.17	122.17	122.17	3.11	0.086
Error	35	1373.09	1373.09	39.23		
Total	36	1495.26				

S = 6.26347 R-Sq = 8.17% R-Sq(adj) = 5.55%

Analysis of Variance for **Overtime,** using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	12.1	12.1	12.1	0.12	0.731
Error	35	3528.7	3528.7	100.8		
Total	36	3540.8				

S = 10.0409 R-Sq = 0.34% R-Sq(adj) = 0.00%

Analysis of Variance for **Any Shift Experience Previously**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.0436	0.0436	0.0436	0.25	0.624
Error	35	6.2267	6.2267	0.1779		
Total	36	6.2703				

S = 0.421788 R-Sq = 0.70% R-Sq(adj) = 0.00%

Analysis of Variance for **Years of Experience in Previous Shift System**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	22.25	22.25	22.25	0.40	0.530
Error	35	1937.48	1937.48	55.36		
Total	36	1959.73				

S = 7.44019 R-Sq = 1.14% R-Sq(adj) = 0.00%

PART II

Analysis of Variance for **Workload,** using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.0811	0.0811	0.0811	0.19	0.666
Error	35	15.0000	15.0000	0.4286		
Total	36	15.0811				

S = 0.654654 R-Sq = 0.54% R-Sq(adj) = 0.00%

Analysis of Variance for **Overall Alertness**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	1.5936	1.5936	1.5936	3.34	0.076
Error	35	16.6767	16.6767	0.4765		
Total	36	18.2703				

S = 0.690273 R-Sq = 8.72% R-Sq(adj) = 6.11%

Analysis of Variance for **Early-stage Alertness**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	2.5427	2.5427	2.5427	4.90	0.033
Error	35	18.1600	18.1600	0.5189		
Total	36	20.7027				

S = 0.720317 R-Sq = 12.28% R-Sq(adj) = 9.78%

Analysis of Variance for **Mid-stage Alertness**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	3.0170	3.0170	3.0170	4.06	0.052
Error	35	26.0100	26.0100	0.7431		
Total	36	29.0270				

S = 0.862057 R-Sq = 10.39% R-Sq(adj) = 7.83%

Analysis of Variance for **Late-stage Alertness**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	3.676	3.676	3.676	2.18	0.149
Error	35	59.027	59.027	1.686		
Total	36	62.703				

S = 1.29864 R-Sq = 5.86% R-Sq(adj) = 3.17%

Analysis of Variance for **Amount of Sleep Needed/Day**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	1.150	1.150	1.150	1.14	0.293
Error	35	35.377	35.377	1.011		
Total	36	36.527				

S = 1.00537 R-Sq = 3.15% R-Sq(adj) = 0.38%

Analysis of Variance for **Amount of Sleep Duration/Day**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	1.4303	1.4303	1.4303	5.66	0.023
Error	35	8.8400	8.8400	0.2526		
Total	36	10.2703				

S = 0.502565 R-Sq = 13.93% R-Sq(adj) = 11.47%

Analysis of Variance for **Difficulty for Initiating Sleep**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.0923	0.0923	0.0923	0.17	0.681
Error	35	18.8267	18.8267	0.5379		
Total	36	18.9189				

S = 0.733420 R-Sq = 0.49% R-Sq(adj) = 0.00%

Analysis of Variance for **Difficulty for Maintaining Sleep**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.0090	0.0090	0.0090	0.02	0.900
Error	35	19.6667	19.6667	0.5619		
Total	36	19.6757				

S = 0.749603 R-Sq = 0.05% R-Sq(adj) = 0.00%

Analysis of Variance for **Waking up Earlier than Intended**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.1041	0.1041	0.1041	0.15	0.703
Error	35	24.7067	24.7067	0.7059		
Total	36	24.8108				

S = 0.840181 R-Sq = 0.42% R-Sq(adj) = 0.00%

Analysis of Variance for **Sleep Disordered Breathing**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.9373	0.9373	0.9373	2.28	0.140
Error	35	14.3600	14.3600	0.4103		
Total	36	15.2973				

S = 0.640535 R-Sq = 6.13% R-Sq(adj) = 3.45%

Analysis of Variance for **Snoring**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.507	0.507	0.507	0.46	0.500
Error	35	38.250	38.250	1.093		
Total	36	38.757				

S = 1.04540 R-Sq = 1.31% R-Sq(adj) = 0.00%

Analysis of Variance for **Sleeplessness**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.0923	0.0923	0.0923	0.25	0.619
Error	35	12.8267	12.8267	0.3665		
Total	36	12.9189				

S = 0.605373 R-Sq = 0.71% R-Sq(adj) = 0.00%

Analysis of Variance for **Sleep Insufficiency**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	1.2332	1.2332	1.2332	3.08	0.088
Error	35	14.0100	14.0100	0.4003		
Total	36	15.2432				

S = 0.632681 R-Sq = 8.09% R-Sq(adj) = 5.46%

Analysis of Variance for **Poor Sleep Quality**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.3136	0.3136	0.3136	0.69	0.413
Error	35	15.9567	15.9567	0.4559		
Total	36	16.2703				

S = 0.675207 R-Sq = 1.93% R-Sq(adj) = 0.00%

Analysis of Variance for **Negative Effect of Shift Type on Sleep**, using Adjusted SS for
Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	2.5125	2.5125	2.5125	4.71	0.037
Error	35	18.6767	18.6767	0.5336		
Total	36	21.1892				

S = 0.730492 R-Sq = 11.86% R-Sq(adj) = 9.34%

Analysis of Variance for **Negative Effect of Overtime on Sleep**, using Adjusted SS for
Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.9009	0.9009	0.9009	1.39	0.246
Error	35	22.6667	22.6667	0.6476		
Total	36	23.5676				

S = 0.804748 R-Sq = 3.82% R-Sq(adj) = 1.07%

Analysis of Variance for **Enough Sleep for Recovering from Fatigue**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.6206	0.6206	0.6206	1.05	0.312
Error	35	20.6767	20.6767	0.5908		
Total	36	21.2973				

S = 0.768610 R-Sq = 2.91% R-Sq(adj) = 0.14%

Analysis of Variance for **Satisfaction with Amount of Sleep**, using Adjusted SS for
Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	1.0704	1.0704	1.0704	1.25	0.271
Error	35	29.9567	29.9567	0.8559		
Total	36	31.0270				

S = 0.925151 R-Sq = 3.45% R-Sq(adj) = 0.69%

Analysis of Variance for **Feeling Rested After Sleep**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.8303	0.8303	0.8303	1.49	0.230
Error	35	19.4400	19.4400	0.5554		
Total	36	20.2703				

S = 0.745271 R-Sq = 4.10% R-Sq(adj) = 1.36%

Analysis of Variance for **Normally Sleep Well**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.1104	0.1104	0.1104	0.16	0.696
Error	35	24.9167	24.9167	0.7119		
Total	36	25.0270				

S = 0.843744 R-Sq = 0.44% R-Sq(adj) = 0.00%

PART III

Analysis of Variance for **Pain in Shoulder/Neck**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.0231	0.0231	0.0231	0.05	0.832
Error	35	17.7067	17.7067	0.5059		
Total	36	17.7297				

S = 0.711270 R-Sq = 0.13% R-Sq(adj) = 0.00%

Analysis of Variance for **Pain in Back/Lower Back**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	7.2663	7.2663	7.2663	9.18	0.005
Error	35	27.7067	27.7067	0.7916		
Total	36	34.9730				

S = 0.889730 R-Sq = 20.78% R-Sq(adj) = 18.51%

Analysis of Variance for **Pain in Arm/Wrist**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.5481	0.5481	0.5481	1.41	0.242
Error	35	13.5600	13.5600	0.3874		
Total	36	14.1081				

S = 0.622438 R-Sq = 3.89% R-Sq(adj) = 1.14%

Analysis of Variance for **Pain in Leg/Knee**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.137	0.137	0.137	0.12	0.728
Error	35	38.890	38.890	1.111		
Total	36	39.027				

S = 1.05411 R-Sq = 0.35% R-Sq(adj) = 0.00%

Analysis of Variance for **Headache**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.1906	0.1906	0.1906	0.29	0.594

Error	35	23.1067	23.1067	0.6602
Total	36	23.2973		

S = 0.812521 R-Sq = 0.82% R-Sq(adj) = 0.00%

Analysis of Variance for **Stomach-ache**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.0758	0.0758	0.0758	0.21	0.646
Error	35	12.3567	12.3567	0.3530		
Total	36	12.4324				

S = 0.594178 R-Sq = 0.61% R-Sq(adj) = 0.00%

Analysis of Variance for **Overall Health Rate**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.0130	0.0130	0.0130	0.04	0.853
Error	35	12.9600	12.9600	0.3703		
Total	36	12.9730				

S = 0.608511 R-Sq = 0.10% R-Sq(adj) = 0.00%

Analysis of Variance for **Satisfaction with Current Schedule**, using Adjusted SS for
Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.0014	0.0014	0.0014	0.00	0.969
Error	35	32.1067	32.1067	0.9173		
Total	36	32.1081				

S = 0.957775 R-Sq = 0.00% R-Sq(adj) = 0.00%

APPENDIX C

STATISTICAL TESTS

Appendix C includes statistical analysis of Part I, Part II and Part III of the questionnaire survey for 8 h Morning Shift versus 8 h Afternoon Shift

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General Linear Model: Part I, Part II and Part III for 8 h Morning Shift versus 8 h Afternoon Shift

```
Factor       Type   Levels  Values
Shift Types  fixed       2  8hA, 8hM
```

PART I

Analysis of Variance for **Age,** using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	7.0061	7.0061	7.0061	18.04	0.000
Error	20	7.7667	7.7667	0.3883		
Total	21	14.7727				

S = 0.623164 R-Sq = 47.43% R-Sq(adj) = 44.80%

Analysis of Variance for **Gender,** using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.0242	0.0242	0.0242	0.19	0.668
Error	20	2.5667	2.5667	0.1283		
Total	21	2.5909				

S = 0.358236 R-Sq = 0.94% R-Sq(adj) = 0.00%

Analysis of Variance for **Marital Status,** using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	1.1879	1.1879	1.1879	3.79	0.066
Error	20	6.2667	6.2667	0.3133		
Total	21	7.4545				

S = 0.559762 R-Sq = 15.93% R-Sq(adj) = 11.73%

Analysis of Variance for **Number of Dependents,** using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.1833	0.1833	0.1833	0.50	0.487
Error	20	7.3167	7.3167	0.3658		
Total	21	7.5000				

S = 0.604842 R-Sq = 2.44% R-Sq(adj) = 0.00%

Analysis of Variance for **Position at NJIT Public Safety Department,** using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.2561	0.2561	0.2561	0.73	0.403
Error	20	7.0167	7.0167	0.3508		
Total	21	7.2727				

S = 0.592312 R-Sq = 3.52% R-Sq(adj) = 0.00%

Analysis of Variance for **Years of Experience in Present Shift System**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	63.36	63.36	63.36	1.09	0.309
Error	20	1164.33	1164.33	58.22		
Total	21	1227.69				

S = 7.62997 R-Sq = 5.16% R-Sq(adj) = 0.42%

Analysis of Variance for **Overtime,** using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	127.4	127.4	127.4	0.95	0.340
Error	20	2669.2	2669.2	133.5		
Total	21	2796.6				

S = 11.5524 R-Sq = 4.56% R-Sq(adj) = 0.00%

Analysis of Variance for **Any Shift Experience Previously**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.0136	0.0136	0.0136	0.06	0.805
Error	20	4.3500	4.3500	0.2175		
Total	21	4.3636				

S = 0.466369 R-Sq = 0.31% R-Sq(adj) = 0.00%

Analysis of Variance for **Years of Experience in Previous Shift System**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	96.22	96.22	96.22	1.41	0.249
Error	20	1365.60	1365.60	68.28		
Total	21	1461.82				

S = 8.26317 R-Sq = 6.58% R-Sq(adj) = 1.91%

PART II

Analysis of Variance for **Workload,** using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.3879	0.3879	0.3879	0.86	0.366
Error	20	9.0667	9.0667	0.4533		
Total	21	9.4545				

S = 0.673300 R-Sq = 4.10% R-Sq(adj) = 0.00%

Analysis of Variance for **Overall Alertness,** using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.6682	0.6682	0.6682	1.54	0.228
Error	20	8.6500	8.6500	0.4325		
Total	21	9.3182				

S = 0.657647 R-Sq = 7.17% R-Sq(adj) = 2.53%

Analysis of Variance for **Early-stage Alertness**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.0015	0.0015	0.0015	0.00	0.949
Error	20	7.3167	7.3167	0.3658		
Total	21	7.3182				

S = 0.604842 R-Sq = 0.02% R-Sq(adj) = 0.00%

Analysis of Variance for **Mid-stage Alertness**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.3409	0.3409	0.3409	0.41	0.531
Error	20	16.7500	16.7500	0.8375		
Total	21	17.0909				

S = 0.915150 R-Sq = 1.99% R-Sq(adj) = 0.00%

Analysis of Variance for **Late-stage Alertness**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	4.418	4.418	4.418	3.22	0.088
Error	20	27.400	27.400	1.370		
Total	21	31.818				

S = 1.17047 R-Sq = 13.89% R-Sq(adj) = 9.58%

Analysis of Variance for **Amount of Sleep Needed/Day**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.700	0.700	0.700	0.54	0.469
Error	20	25.754	25.754	1.288		
Total	21	26.455				

S = 1.13477 R-Sq = 2.65% R-Sq(adj) = 0.00%

Analysis of Variance for **Amount of Sleep Duration/ Day**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.0545	0.0545	0.0545	0.22	0.642
Error	20	4.9000	4.9000	0.2450		
Total	21	4.9545				

S = 0.494975 R-Sq = 1.10% R-Sq(adj) = 0.00%

Analysis of Variance for **Difficulty for Initiating Sleep**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	2.9333	2.9333	2.9333	6.85	0.017
Error	20	8.5667	8.5667	0.4283		
Total	21	11.5000				

S = 0.654472 R-Sq = 25.51% R-Sq(adj) = 21.78%

Analysis of Variance for **Difficulty Maintainin Sleep,** using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.2970	0.2970	0.2970	0.49	0.491
Error	20	12.0667	12.0667	0.6033		
Total	21	12.3636				

S = 0.776745 R-Sq = 2.40% R-Sq(adj) = 0.00%

Analysis of Variance for **Waking up Earlier than Intended**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.2970	0.2970	0.2970	0.37	0.550
Error	20	16.0667	16.0667	0.8033		
Total	21	16.3636				

S = 0.896289 R-Sq = 1.81% R-Sq(adj) = 0.00%

Analysis of Variance for **Sleep-disordered Breathing**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.0061	0.0061	0.0061	0.04	0.849
Error	20	3.2667	3.2667	0.1633		
Total	21	3.2727				

S = 0.404145 R-Sq = 0.19% R-Sq(adj) = 0.00%

Analysis of Variance for **Snoring**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.000	0.000	0.000	0.00	1.000
Error	20	24.000	24.000	1.200		
Total	21	24.000				

S = 1.09545 R-Sq = 0.00% R-Sq(adj) = 0.00%

Analysis of Variance for **Sleeplessness,** using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	1.1879	1.1879	1.1879	2.87	0.106
Error	20	8.2667	8.2667	0.4133		
Total	21	9.4545				

S = 0.642910 R-Sq = 12.56% R-Sq(adj) = 8.19%

Analysis of Variance for **Sleep Insufficiency**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.5470	0.5470	0.5470	2.87	0.106
Error	20	3.8167	3.8167	0.1908		
Total	21	4.3636				

S = 0.436845 R-Sq = 12.53% R-Sq(adj) = 8.16%

Analysis of Variance for **Poor Sleep Quality,** using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.0242	0.0242	0.0242	0.07	0.796
Error	20	7.0667	7.0667	0.3533		
Total	21	7.0909				

S = 0.594418 R-Sq = 0.34% R-Sq(adj) = 0.00%

Analysis of Variance for **Negative Effect of Shift Type on Sleep,** using Adjusted SS for
Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.0742	0.0742	0.0742	0.21	0.650
Error	20	7.0167	7.0167	0.3508		
Total	21	7.0909				

S = 0.592312 R-Sq = 1.05% R-Sq(adj) = 0.00%

Analysis of Variance for **Negative Effect of Overtime on Sleep,** using Adjusted SS for
Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.0545	0.0545	0.0545	0.08	0.774
Error	20	12.9000	12.9000	0.6450		
Total	21	12.9545				

S = 0.803119 R-Sq = 0.42% R-Sq(adj) = 0.00%

Analysis of Variance for **Enough Sleep for Recovering from Fatigue**, using Adjusted SS for
Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.0742	0.0742	0.0742	0.11	0.739
Error	20	13.0167	13.0167	0.6508		
Total	21	13.0909				

S = 0.806742 R-Sq = 0.57% R-Sq(adj) = 0.00%

Analysis of Variance for **Satisfied with Amount of Sleep**, using Adjusted SS for
Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	1.4561	1.4561	1.4561	2.19	0.155
Error	20	13.3167	13.3167	0.6658		
Total	21	14.7727				

S = 0.815986 R-Sq = 9.86% R-Sq(adj) = 5.35%

Analysis of Variance for **Feeling Rested After Sleep**, using Adjusted SS for
Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.6682	0.6682	0.6682	1.54	0.228
Error	20	8.6500	8.6500	0.4325		
Total	21	9.3182				

S = 0.657647 R-Sq = 7.17% R-Sq(adj) = 2.53%

Analysis of Variance for **Normally Sleep Well**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.5470	0.5470	0.5470	0.97	0.337
Error	20	11.3167	11.3167	0.5658		
Total	21	11.8636				

S = 0.752219 R-Sq = 4.61% R-Sq(adj) = 0.00%

PART III

Analysis of Variance for **Pain in Shoulder/Neck,** using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.8727	0.8727	0.8727	1.76	0.199
Error	20	9.9000	9.9000	0.4950		
Total	21	10.7727				

S = 0.703562 R-Sq = 8.10% R-Sq(adj) = 3.51%

Analysis of Variance for **Pain in Back/Lower Back**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.0061	0.0061	0.0061	0.01	0.923
Error	20	12.7667	12.7667	0.6383		
Total	21	12.7727				

S = 0.798958 R-Sq = 0.05% R-Sq(adj) = 0.00%

Analysis of Variance for **Pain in Arm/Wrist**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.4909	0.4909	0.4909	4.68	0.043
Error	20	2.1000	2.1000	0.1050		
Total	21	2.5909				

S = 0.324037 R-Sq = 18.95% R-Sq(adj) = 14.89%

Analysis of Variance for **Pain in Leg/Knee**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.218	0.218	0.218	0.20	0.658
Error	20	21.600	21.600	1.080		
Total	21	21.818				

S = 1.03923 R-Sq = 1.00% R-Sq(adj) = 0.00%

Analysis of Variance for **Headache**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.0742	0.0742	0.0742	0.10	0.756

```
Error        20  15.0167  15.0167  0.7508
Total        21  15.0909


S = 0.866506   R-Sq = 0.49%   R-Sq(adj) = 0.00%
```

Analysis of Variance for **Stomach-ache**, using Adjusted SS for Tests

```
Source       DF  Seq SS  Adj SS  Adj MS     F      P
Shift Types   1  0.2970  0.2970  0.2970  1.46  0.241
Error        20  4.0667  4.0667  0.2033
Total        21  4.3636


S = 0.450925   R-Sq = 6.81%   R-Sq(adj) = 2.15%
```

Analysis of Variance for **Overall Health Rate**, using Adjusted SS for Tests

```
Source       DF  Seq SS  Adj SS  Adj MS     F      P
Shift Types   1  0.7333  0.7333  0.7333  2.02  0.171
Error        20  7.2667  7.2667  0.3633
Total        21  8.0000


S = 0.602771   R-Sq = 9.17%   R-Sq(adj) = 4.62%
```

Analysis of Variance for **Satisfaction with Current Schedule**, using Adjusted SS for
Tests

```
Source       DF   Seq SS   Adj SS  Adj MS     F      P
Shift Types   1   2.6727   2.6727  2.6727  3.79  0.066
Error        20  14.1000  14.1000  0.7050
Total        21  16.7727


S = 0.839643   R-Sq = 15.93%   R-Sq(adj) = 11.73%
```

APPENDIX D

STATISTICAL TESTS

Appendix D includes statistical analysis of Part I, Part II and Part III of the questionnaire survey for 8 h Morning shift versus 12 h Day shift.

General Linear Model: Part I, Part II and Part III for 8 h Morning Shift versus 12 h Day Shift

```
Factor       Type   Levels  Values
Shift Types  fixed       2  12hD, 8hM
```

PART I

Analysis of Variance for **Age,** using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	2.0250	2.0250	2.0250	4.06	0.061
Error	16	7.9750	7.9750	0.4984		
Total	17	10.0000				

S = 0.706001 R-Sq = 20.25% R-Sq(adj) = 15.27%

Analysis of Variance for **Gender**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.0028	0.0028	0.0028	0.03	0.876
Error	16	1.7750	1.7750	0.1109		
Total	17	1.7778				

S = 0.333073 R-Sq = 0.16% R-Sq(adj) = 0.00%

Analysis of Variance for **Marital Status**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.1361	0.1361	0.1361	0.40	0.537
Error	16	5.4750	5.4750	0.3422		
Total	17	5.6111				

S = 0.584968 R-Sq = 2.43% R-Sq(adj) = 0.00%

Analysis of Variance for **Number of Dependents**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.1000	0.1000	0.1000	0.20	0.659
Error	16	7.9000	7.9000	0.4937		
Total	17	8.0000				

S = 0.702673 R-Sq = 1.25% R-Sq(adj) = 0.00%

Analysis of Variance for **Position at NJIT Public Safety Department**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	14.400	14.400	14.400	37.77	0.000
Error	16	6.100	6.100	0.381		
Total	17	20.500				

S = 0.617454   R-Sq = 70.24%   R-Sq(adj) = 68.38%

Analysis of Variance for **Years of Experience in Present Shift System**, using Adjusted SS for
Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	147.58	147.58	147.58	2.92	0.107
Error	16	807.32	807.32	50.46		
Total	17	954.90				

S = 7.10334   R-Sq = 15.46%   R-Sq(adj) = 10.17%

Analysis of Variance for **Overtime**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	3.4	3.4	3.4	0.02	0.885
Error	16	2526.4	2526.4	157.9		
Total	17	2529.8				

S = 12.5658   R-Sq = 0.13%   R-Sq(adj) = 0.00%

Analysis of Variance for **Any Shift Experience Previously**, using Adjusted SS for
Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.0111	0.0111	0.0111	0.05	0.827
Error	16	3.6000	3.6000	0.2250		
Total	17	3.6111				

S = 0.474342   R-Sq = 0.31%   R-Sq(adj) = 0.00%

Analysis of Variance for **Years of Experience in Previous Shift System**, using Adjusted SS for
Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	29.47	29.47	29.47	0.42	0.524
Error	16	1113.47	1113.47	69.59		
Total	17	1142.94				

S = 8.34219   R-Sq = 2.58%   R-Sq(adj) = 0.00%

PART II

Analysis of Variance for **Workload,** using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.0028	0.0028	0.0028	0.01	0.942
Error	16	8.2750	8.2750	0.5172		
Total	17	8.2778				

S = 0.719157   R-Sq = 0.03%   R-Sq(adj) = 0.00%

Analysis of Variance for **Overall Alertness**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	1.0028	1.0028	1.0028	3.04	0.100
Error	16	5.2750	5.2750	0.3297		
Total	17	6.2778				

S = 0.574184   R-Sq = 15.97%   R-Sq(adj) = 10.72%

Analysis of Variance for **Early-stage Alertness**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	3.2111	3.2111	3.2111	5.19	0.037
Error	16	9.9000	9.9000	0.6187		
Total	17	13.1111				

S = 0.786607   R-Sq = 24.49%   R-Sq(adj) = 19.77%

Analysis of Variance for **Mid-stage Alertness**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	1.7361	1.7361	1.7361	2.44	0.138
Error	16	11.3750	11.3750	0.7109		
Total	17	13.1111				

S = 0.843171   R-Sq = 13.24%   R-Sq(adj) = 7.82%

Analysis of Variance for **Late-stage Alertness**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	2.669	2.669	2.669	2.11	0.166
Error	16	20.275	20.275	1.267		
Total	17	22.944				

S = 1.12569   R-Sq = 11.63%   R-Sq(adj) = 6.11%

Analysis of Variance for **Amount of Sleep Needed/Day**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.2250	0.2250	0.2250	0.30	0.590
Error	16	11.9000	11.9000	0.7438		
Total	17	12.1250				

S = 0.862409   R-Sq = 1.86%   R-Sq(adj) = 0.00%

Analysis of Variance for **Amount of Sleep Duration/ Day**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.7111	0.7111	0.7111	2.32	0.147
Error	16	4.9000	4.9000	0.3062		
Total	17	5.6111				

S = 0.553399 R-Sq = 12.67% R-Sq(adj) = 7.22%

Analysis of Variance for **Difficulty for Initiating Sleep**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	1.8778	1.8778	1.8778	6.83	0.019
Error	16	4.4000	4.4000	0.2750		
Total	17	6.2778				

S = 0.524404 R-Sq = 29.91% R-Sq(adj) = 25.53%

Analysis of Variance for **Difficulty for Maintaining Sleep**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.3361	0.3361	0.3361	0.74	0.403
Error	16	7.2750	7.2750	0.4547		
Total	17	7.6111				

S = 0.674305 R-Sq = 4.42% R-Sq(adj) = 0.00%

Analysis of Variance for **Waking up Earlier than Intended**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.3361	0.3361	0.3361	0.74	0.403
Error	16	7.2750	7.2750	0.4547		
Total	17	7.6111				

S = 0.674305 R-Sq = 4.42% R-Sq(adj) = 0.00%

Analysis of Variance for **Sleep-disordered Breathing**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	1.3444	1.3444	1.3444	1.94	0.183
Error	16	11.1000	11.1000	0.6937		
Total	17	12.4444				

S = 0.832917 R-Sq = 10.80% R-Sq(adj) = 5.23%

Analysis of Variance for **Snoring,** using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	1.111	1.111	1.111	0.99	0.335
Error	16	18.000	18.000	1.125		
Total	17	19.111				

S = 1.06066 R-Sq = 5.81% R-Sq(adj) = 0.00%

Analysis of Variance for **Sleeplessness,** using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.4000	0.4000	0.4000	1.78	0.201
Error	16	3.6000	3.6000	0.2250		
Total	17	4.0000				

S = 0.474342 R-Sq = 10.00% R-Sq(adj) = 4.38%

Analysis of Variance for **Sleep Insufficiency**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	2.6694	2.6694	2.6694	7.40	0.015
Error	16	5.7750	5.7750	0.3609		
Total	17	8.4444				

S = 0.600781 R-Sq = 31.61% R-Sq(adj) = 27.34%

Analysis of Variance for **Poor Sleep Quality**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	1.2250	1.2250	1.2250	2.11	0.165
Error	16	9.2750	9.2750	0.5797		
Total	17	10.5000				

S = 0.761372 R-Sq = 11.67% R-Sq(adj) = 6.15%

Analysis of Variance for **Negative Effect of Shift Type on Sleep**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	2.1778	2.1778	2.1778	3.45	0.082
Error	16	10.1000	10.1000	0.6312		
Total	17	12.2778				

S = 0.794512 R-Sq = 17.74% R-Sq(adj) = 12.60%

Analysis of Variance for **Negative Effect of Overtime on Sleep**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.0028	0.0028	0.0028	0.00	0.952
Error	16	11.7750	11.7750	0.7359		

Total 17 11.7778

S = 0.857868 R-Sq = 0.02% R-Sq(adj) = 0.00%

Analysis of Variance for **Enough Sleep for Recovering from Fatigue**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.4000	0.4000	0.4000	0.53	0.478
Error	16	12.1000	12.1000	0.7562		
Total	17	12.5000				

S = 0.869626 R-Sq = 3.20% R-Sq(adj) = 0.00%

Analysis of Variance for **Satisfaction with Amount of Sleep**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	1.6000	1.6000	1.6000	2.46	0.136
Error	16	10.4000	10.4000	0.6500		
Total	17	12.0000				

S = 0.806226 R-Sq = 13.33% R-Sq(adj) = 7.92%

Analysis of Variance for **Feeling Rested After Sleep**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	1.0028	1.0028	1.0028	2.21	0.157
Error	16	7.2750	7.2750	0.4547		
Total	17	8.2778				

S = 0.674305 R-Sq = 12.11% R-Sq(adj) = 6.62%

Analysis of Variance for **Normally Sleep Well**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.7111	0.7111	0.7111	0.92	0.352
Error	16	12.4000	12.4000	0.7750		
Total	17	13.1111				

S = 0.880341 R-Sq = 5.42% R-Sq(adj) = 0.00%

PART III

Analysis of Variance for **Pain in Shoulder/Neck**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.3361	0.3361	0.3361	0.79	0.386
Error	16	6.7750	6.7750	0.4234		
Total	17	7.1111				

S = 0.650721   R-Sq = 4.73%   R-Sq(adj) = 0.00%

Analysis of Variance for **Pain in Back/Lower Back**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	4.9000	4.9000	4.9000	6.76	0.019
Error	16	11.6000	11.6000	0.7250		
Total	17	16.5000				

S = 0.851469   R-Sq = 29.70%   R-Sq(adj) = 25.30%

Analysis of Variance for **Pain in Arm/Wrist**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.1778	0.1778	0.1778	0.47	0.504
Error	16	6.1000	6.1000	0.3812		
Total	17	6.2778				

S = 0.617454   R-Sq = 2.83%   R-Sq(adj) = 0.00%

Analysis of Variance for **Pain in Leg/Knee**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.025	0.025	0.025	0.02	0.891
Error	16	20.475	20.475	1.280		
Total	17	20.500				

S = 1.13123   R-Sq = 0.12%   R-Sq(adj) = 0.00%

Analysis of Variance for **Headache**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.4000	0.4000	0.4000	0.53	0.478
Error	16	12.1000	12.1000	0.7563		
Total	17	12.5000				

S = 0.869626   R-Sq = 3.20%   R-Sq(adj) = 0.00%

Analysis of Variance for **Stomach-ache**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.2250	0.2250	0.2250	0.57	0.460
Error	16	6.2750	6.2750	0.3922		
Total	17	6.5000				

S = 0.626249   R-Sq = 3.46%   R-Sq(adj) = 0.00%

Analysis of Variance for **Overall Health Rate**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.1778	0.1778	0.1778	0.51	0.486
Error	16	5.6000	5.6000	0.3500		
Total	17	5.7778				

S = 0.591608 R-Sq = 3.08% R-Sq(adj) = 0.00%

Analysis of Variance for **Satisfaction with Current Schedule**, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Shift Types	1	0.1778	0.1778	0.1778	0.28	0.603
Error	16	10.1000	10.1000	0.6312		
Total	17	10.2778				

S = 0.794512 R-Sq = 1.73% R-Sq(adj) = 0.00%

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