The effect of shift work on police officers' stress, sleep quality, and cognitive performance in Sharjah Police Workforce.

Bushra Almheiri and Hamad Rashid
Department of Industrial Engineering and Engineering Management
University of Sharjah
Sharjah, United Arab Emirates
U18104305@sharjah.ac.ae, hamad.rashid@sharjah.ac.ae

Abstract

Police officers are first responders, therefore shift work in this sector is imperative in order to ensure 24/7 coverage. The demanding nature of the pressing work schedules may have physiological, psychological, or other mental impacts on the workforce. Hence, it's necessary to study the association between the shift work and stress, sleep quality, and cognitive performance within the workforce. Data were obtained from 307 participants working in Sharjah Police. In this study, stress was assessed using 22 items from Spielberger Police Stress Survey, respondents indicated the level of perceived stress on a 5-point Likert scale during a three months period. The sleep quality was assessed using Pittsburgh Sleep Quality Index (PSQI) through a questionnaire that included 12 items, where respondents were required to indicate the hours of their daily sleep during the three months period and rate the extent to which a number of different factors affected their sleep on a 4-point Likert scale. Furthermore, cognitive performance was assessed using 10 items from Cognitive Functioning Self-Assessment Scale (CFSS) Questionnaire, where respondents are required to rate different events' frequencies on a 5-point Likert scale. Statistical analysis is conducted using SPSS where analysis of variance is utilized. Results showed important correlations between shiftwork and sleep quality, while shiftwork impact on stress, and cognitive performance of the participants is found to be insignificant.

Keywords
Shift work, Police Stress, Sleep quality, Cognitive performance.

1. Introduction

Shift work is a pattern where work differs from the traditional working day and week, in which the employee on the next shift takes over the same role within a 24-hr period (Richbell and Chan, 2011). Shifts have become prevalent in many developed countries (Drake and Wright, 2011). It is crucial in many sectors to provide services across all 24 hours of the day throughout the week, including protective service providers such as police workforce and other emergency responders who make sure to provide communities with adequate safety and security. Due to the distinctive nature of responsibilities among the different police workforce departments (e.g., patrol officers have different responsibilities than those of jailers), multiple shift rosters were set, and were also affected by other variables such as number of staff and demand for service. Despite the fact that shift work is an essential element of the vocation, there is increasing evidence in recent studies that shift work could result in fatigue, sleep disorders, occupational stress, health issues, social lives, psychological and physiological disturbance...etc.

Shift workers are required to reschedule their sleeping pattern where their sleeping and awakening times are constantly changing, which can result in a circadian rhythm disruption (Violanti et al., 2008). Generally, humans' circadian timings are mainly affected by environmental lightning exposure, where morning light boost rhythms and evening light delays them (Boivin et al., 1996; Minors et al., 1991). This disruption can lead to mood changes, abnormal hormone rhythms, cognitive function impairment (Horne, 2007), and other health issues such as cardiovascular diseases, diabetes (Guo et al., 2013)), obesity, metabolic syndrome (Karlsson et al., 2001), and cancer (Haus and Smolensky, 2013). Yazdi et al. (2014) found that shift workers are more susceptible to insomnia, poor sleep quality, and daytime sleepiness. Working rotating shifts or night schedules is associated with insomnia and excessive

sleepiness (Drake et al., 2004). Mohr et al. (2003) found that insufficient sleep increases traumatic stress, resulting in poor health functioning among police officers.

Police work requires working at night when cognition, alertness, and vigilance are at their lowest levels (Horrocks and Pounder, 2006). Shift work and fatigue result in disturbed sleep and impaired cognition (Wright et al., 2013; Chang et al., 2011). Night shift workers' average sleep is 2 hours less than of those working day shifts (Torsvall, Akerstedt, Gillander and Knutsson, 1989). Insomnia is associated with poorer cognitive performance (Wardle-Pinkston et al., 2019). Circadian misalignment can lower working memory, visual attention, shape perception which could lead to higher accident risks and poor performance (Durmer and Dinges, 2005; Killgore, 2010; Åkerstedt and Wright, 2009; Karatsoreos, 2012). Cognitive performance can be measured subjectively using self-reported questionnaires or objectively using multiple cognitive tests/tasks to demonstrate the effect that lack of sleep has on cognition and driving (Wardle-Pinkston et al., 2019; Alhola and Polo-Kantola, 2007; Lamport et al., 2016).

Due to the nature of their job, police officers are exposed to several job-related stressors including excessive workload, social life/work imbalance, lack of communication and support (Collins and Gibbs, 2003), that can lead to changes in the worker's psychological and/or physiological state (Richardson and Rothstein, 2008). Occupational stressors can negatively impact the mental state of the employee causing anxiety, depression, aggressive behavior, nervous exhaustion, emotional outbursts, impulsivity, overeating, poor decision making and concentration distractions (Darvishi et al., 2014; Magnavita, 2000). Police officers' traumatic experience was highly affected by shift work as it highly increased the psychopathological symptoms (Polumair et al, 1998). Shift work can also be described as one of the stressors in police work (Gerber et al., 2010). It has been proved that shift work negatively impact health and sleep among officers with chronic stress (Hobfoll,1998). The nature of police officer's occupation exposes them to a higher stressors level compared to other occupations (Garbarino et al., 2011; McCafferty et al., 1992).

1.1 Objectives

This study is aimed at comparing between shift workers and non-shift workers in terms of levels of stress, sleep quality and cognitive performance among Sharjah Police Workforce officers. Furthermore, this study investigates whether other factors such as age, gender, and rank could possibly have an impact on the stress levels, sleep quality scores, and cognitive performance scores of participants.

2. Literature Review

This literature review provides an insight of the different methods and relevant insights that had been provided by researchers to measure stress, sleep quality, and cognitive performance.

2.1 Shift Work and Sleep Quality

Several health issues can arise from working or staying up the entire night **(**Nabe-Nielsen et al**.,** 2016). An employee might suffer from digestion problem, lack of sleep, stomach ulcer, insomnia and many other health problems. Jensen et al. (2016) had supported this theory and further added that rotational shift can cause many problems for an employee, especially employees who are older than 40 years. Sleep quality refers to the sleeping pattern and sleeping duration of a person. Sleep promotes good blood circulation and facilitates metabolism rate along with helping the brain to work faster and quicker **(**Ang et al**.,** 2017). Likewise sleep quality plays an important role in an individual's regular life. In this aspect, it should be mentioned that sleep quality of a police personnel may get disturbed for their indistinct working hours. Given the fact that a normal sleeping hour is usually in the night, police officers, who have night duties may suffer from sleep deprivation or many other health issues **(**Ma et al**.,** 2020). There are several subject and objective methods of measuring sleep quality. Subjective sleep refers to observing sleeping patterns and duration, it includes the parameters of sleep continuity, initiation and the depth of sleep**,** where physical and mental health of a person depends on these parameters significantly to provide a healthy life **(**Scholarios et al**.,** 2017).
Disturbing sleep or inadequate sleep also disturbs the regular life of a person. In terms of measuring sleep quality of police officers, Pittsburgh Sleep Quality and Sleep Diary has been considered to be elaborated. The prime agenda of Pittsburgh Sleep Quality Index or PSQI is to provide a valid and standardized measure of sleep quality to the clinicians that can help them to categorize and discriminate between 'good' or 'bad' sleepers. Pittsburgh Sleep Quality assesses sleep quality by utilizing seven different attributes like: sleep quality, duration, latency, disturbance, habitual sleep efficiency, implementing medication for sleeping as well as daytime dysfunction **(**Suwandi, and Kim, 2020**).** Gerber et al. (2010) have measured sleeping quality via PSQI and Insomnia Severity Index. A German version of the PSQI was adapted, which consisted of 12 items, 10 of those items were based on typical workdays. Answers were anchored

on an 8-point Likert-type scale in terms of participants' emotional state right after waking up, perceived quality of sleep, restoration, and mood. Also, their emotional state during work; sleepiness and concentration. Lastly, their emotional state before going to bed; sleepiness and mood. Answers varied from 1 (meaning the participant had very bad sleep quality, not at all restored, and very bad mood) to 8 (meaning very good sleep quality, completely restored, and very good mood). Two additional items were related to apnea symptoms regarding whether and how strong they snore during sleep and how often was their breathing suspended during sleep. Results have shown significant main effect of shift status on sleep. Where shift workers reported significantly more sleep related complaints than non-shift workers. Shift workers were also less satisfied with their sleep after waking up. The authors have also concluded that shift status is not related to daytime and evening mood, concentration and sleepiness.
Furthermore, Ma et al. (2019) have also implemented PSQI to assess sleep quality. The questionnaire consisted of 19 items that evaluate the different factors that affect sleep quality during the previous one-month period. Answers were anchored on a 4-point Likert scale ranging from 0 to 3. The questions were related to subjective sleep quality, sleep duration, sleep latency, sleep disturbances, habitual sleep efficiency, use of sleep medication, and daytime dysfunction. The scoring was based on a global sleep quality score developed by Buysse et al (1989). where a continuous variable was obtained by adding up the scores of the seven components resulting in a score ranging from 0 to 21. Higher scores indicate poorer sleep quality. A participant with a score greater than 5 is considered to have poor sleep quality (Buysse et al., 1989). Analysis were conducted using a statistical analysis software "SAS". Results have shown that male officers averaged a sleeping quality score of 6.3 while female officers averaged 7, given the fact that 78.6% female officers work the day shift whereas only 29% of male officers work the day shift.

2.2 Shift Work and Cognitive Performance

Cognitive performance basically refers to the process of human brains that enable a person to stimulate thought process, it addresses all the rational, logical, reasoning, thinking, learning, remembering and moreover, decision-making process of the brain. In simple words, cognitive performance refers to every action that requires involvement of the brain. In police workforce, the involvement of cognitive performance is high in order to investigate along with doing other administrative tasks. De Souza-Talarico et al (2020) have elaborated that there are several types of procedures to measuring cognitive performance including Motor praxis task, visual object learning task, digital symbol substitution task, psychomotor vigilance **...etc**. Taylor et al. (2019) conducted a study to examine the effect of a forward rotating shift on cognitive performance among police officers in North Yorkshire. A sample size of 23 police officers was chosen to work in a forward rotating shift pattern. The test was conducted in a duration of 10 days, sleep data was obtained using actigraphy which is a method used to measure and monitor the human cycle of rest and activity. Self-reported methods were also implemented where participants performed; the motor praxis test, visual object learning test, n-back, digital symbol substitution task, and psychomotor vigilance test in order to measure vigilance and cognitive performance. Followed by statistical analysis to compare results, taking into consideration shift type (day, afternoon, night), shift number with only 2 levels whereas shift 1 is the first day/afternoon/night shift and shift 2 is the second such shift, and start/end of each shift. Results have shown that there is a significant decrease in sleep duration after night shifts. Visual object test and NBACK results significantly varied according to shift type. Authors have also noticed that start/end had a significant effect in the digital substitution task.
Furthermore, Proctor et al. (1996) have measured cognitive performance in a sample of 284 automotive workers using the neurobehavioral test performance, which is a measure of the damage to the central nervous system which can be caused by neurotoxic substances exposure, neurotoxic medicine usage, metabolic diseases such as diabetes. Neurobehavioral testing is non-invasive and its used to evaluate how a person's central nervous system functions. The computerized Neurobehavioral Evaluation System (NES) has a set of different tests to measure psychomotor speed and control, perceptual speed, attention, and learning. A short version of the NES exam is called the Central Nervous System (CNS) exam component and it is the most widely used computerized NES ("NHANES III - Examination Data File", 2020). Moreover, Guyette et al. (2012) have tested the effects of shift length on cognitive performance in a sample of 34 air medical providers using a battery of neuropsychological tests. These tests included Paced Authority Serial Addition Test (PASAT), University of Southern California Repeatable Episodic Memory Test (USC-REMT), Trial Making Test (TMT), and Stroop Color-Word Test. The tests were used at the start and end of shift to test the change in cognitive performance.
Other subjective methods can be utilized to assess cognitive performance such as the Cognitive Self Efficacy Questionnaire, which is a self-reporting questionnaire used to assess the respondents' recognizing, managing and performing cognitively multifaceted functional activities such as multi-tasking and making decisions in unfamiliar conditions (Toglia et al., 2020). The Daily Living Questionnaire can also be implemented to study cognitive performance as it is a self-reporting questionnaire used to detect everyday activities difficulties that are caused by cognitive deficiency and to examine its validity and reliability (Rosenblum et al., 2017). Another questionnaire used

for the assessment of cognitive functional abilities is the Measurement of Everyday Cognition (ECog) (Farias et al., 2008). Cognitive Functioning Self-Assessment Scale (CFSS) is also a self-reporting questionnaire consisting of 18 items anchored on a 5-point Liker scale used to assess cognitive functioning (Annunziata et al., 2012).

2.3 Shift Work and Stress

Stress can be both physical and mental. It can arise from work pressure, family and financial issues, as well as society. Stress can make a person frustrated, depressed, nervous, angry or suicidal. Epel et al. (2018) have described this as a response from the body to a demand or challenge. The authors also added that police officers are always under a huge amount of pressure as the prime agenda of the workforce is to protect the civilians and the country from any kind of danger. Crosswell and Lockwood (2020) described stress can be measured through physiological changes and can be evaluated through blood, saliva, urine and proxy autonomic measures. There are several methods to measure stress levels. These methods have been generally grouped as destructive, semi-destructive and non-destructive; strain relaxation based as well as many other methods. All these residual stress measurement procedures or methods are indirect. However, there are subjective measures such as Spielberger Police Stress Survey.

The Spielberger police stress survey comprises instruments of 60 items for assessing specific sources of stress, particularly in police workforce. The 60 items from the survey also were divided into three divisions (Administrative/ Professional, Physical/Psychological danger, and lack of support). For each item, the police officers were given rates from 0 to 100; where 0 means no stress and 100 imply maximum stress, frequency of each event's occurrence is also considered. The 60 items from the survey also were divided into three divisions. Spielberger first introduced stress rates for a wide set of events that could happen in policework where officers were tested and monitored (Ogawa et al., 2019). They were monitored for understanding their stress level, frequency of occurring stress and many other aspects. Ma et al. (2015) have studied the association between shift work and police work related stress. The authors have used the Spielberger Police Stress Survey to assess the stressful events officers have faced during the previous month and year. A sample of 365 police officers was obtained, aged between 27 and 66 years. Each participant had to define his dominant shift based on the highest amount of time spent working the day shift, afternoon, or night. Data was analyzed using variance and covariance analysis to study the stressful events during a particular shift. Results have shown that day shift officers have faced less stressful events than those working afternoon and night shifts.

A later study by Ma et al. (2019) have examined the association between police work related stress and sleep quality. They investigate if stress severity, frequency of stressors, and police work characteristics (prior military experience, workload, police rank, shift work) can lead to poor sleep quality among officers. A sample of 365 police officers was obtained from the Buffalo Cardio-Metabolic Occupational Police Stress Study. Using the Spielberger Police Stress Survey data, a mean stress rating score and mean stressors frequency was calculated for each participant. Moreover, Pittsburgh Sleep Quality Index was utilized to assess sleep quality. The authors tested if a linear relationship existed between stress rating scores and frequency of stressors with sleep quality. Stress rating score had a positive independent linear relationship with poor sleep quality. Frequency of stressors also had a positive independent linear relationship with poor sleep quality. The authors also recommend the use of stress coping or sleep promotion regimens for officers suffering from high workloads. Moreover, Gerber et al. (2010) studied the association between different shift systems and stress, sleep, and health among police officers. The authors performed a cross sectional survey. A sample of 460 police officers filled a written questionnaire, 251 were shift workers. Stress analysis was conducted using Trier Inventory for the Assessment of Chronic Stress "TICS" which included 57 items reviewing distinct potential stressful factors and stressful conditions in the workplace. Perceived health was assessed using the Medical Outcomes Study 12-Item Short Form Health Survey "SF-12", somatic complaints, and health care use. Whereas sleep quality was examined using Pittsburgh Sleep Quality Index "PSQI" and Insomnia Severity Index "ISI". Results have shown that shift work contributed to increased social stress, work dissatisfaction, and sleep complaints. There was also an association between stress and sleep complaints, and between stress and lower scores in perceived health. Nevertheless, the relationship between stress and shift work did not have any significant effects.

3. Methods

3.1 Participants

All police officers working in Sharjah Police were invited to answer a written questionnaire assessing police stress, sleep quality, and cognitive performance. The purpose of the study was explained in the questionnaire and participation was voluntary. A sample of 307 officers was obtained, the sample consisted of 279 males (90.88%) and 28 females (9.12%), respondents' mean age was between 25 and 44, where 155 (50.49%) of the sample were non-

shift workers whereas the remining 152 (49.51%) officers worked in shifts as shown in Table 1. Participants took an average of 5 to 8 minutes to complete the questionnaire.

Table 1. Demographic information

	Criteria	Frequency	Percentage
Age Group	18-24	35	11.40%
	25-34	117	38.11%
	35-44	110	35.83%
	45-54	43	14.01%
	55-64	2	0.65%
Gender	Male	279	90.88%
	Female	28	9.12%
Police Rank	Officers (Lieutenant – General)	104	33.88%
	1st Policeman – 1st Warrant Officer	153	49.84%
	Policeman	45	14.66%
	Civil Servants	5	1.63%

3.2 Police Stress Assessment

Spielberger Police Stress Survey was utilized to assess work stress (Spielberger, 1981), It is a self-reporting survey consisting of 60-items designed to assess acute and chronic stressors in police work that occurred in the past month and year. Only 22-items were included in the questionnaire due to the different circumstances in the United Arab Emirates, irrelative items were excluded. In this study, the Spielberger's survey participants were asked to evaluate stress in a scale from 0 to 100 and estimate the frequency of event occurrence, in this study participants were asked to evaluate each event based on a 5-point Likert scale (Non-stressful – Very Stressful) during the past three months. Where responses varied from non-stressful (score = 0), less stressful (score = 1), stressful (score = 2), very stressful (score = 3), and not applicable (not included in the score). Scores of all 22 questions were summed up and multiplied by the number of questions (excluding the not applicable questions), where higher scores indicate higher stress rates.

3.3 Sleep Quality Assessment

Sleep quality was evaluated using Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1989), which is a self-reporting survey consisting of 19-items that examine subjective sleep quality, sleep latency, duration of sleep, habitual efficiency of sleep, use of medication to sleep, sleep disturbances, and dysfunction during the day, where respondents are required to assess different sleep quality factors impact during the past month. In this study, 12-items of the questionnaire were chosen, respondents were required to assess those different factors on a 4-point Likert scale during the past month. Where Buyssee scoring method was utilized to score each item, such that respondents who require 15 or less minutes to fall asleep get a score of 0, while respondents requiring 16 to 30 minutes get a score of 1, respondents requiring 31 to 60 minutes get a score of 2, and respondents requiring more than 60 minutes get a score of 3. As for hours of sleep per night, greater than 7 hours of sleep corresponds to a score of 0, 6 to 7 hours corresponds to a score 1, 5 to 6 hours corresponds to a score of 2, less than 5 hours corresponds to a score of 3. Remaining items were anchored on a 4-point liker scale ranging between not during the past three months, less than once a week, once or twice a week, three or more times a week and corresponding scores were 0, 1, 2, and 3 consecutively. All scores were summed up and multiplied by the number of items (14 items), where higher scores indicate poorer sleep quality.

3.4 Cognitive Performance Assessment

Cognitive performance was assessed using 10 items from Cognitive Functioning Self-Assessment Scale (CFSS) Questionnaire (Annunziata et al., 2012), which includes 18 questions, where respondents are required to rate different events' frequencies on a 5-point Likert scale anchored (never-always) in the period of the past 12 months. However, in this study respondents were required to assess 10 different events during the previous three months period only. Responses varied between never (score = 0), rarely (score = 1), sometimes (score = 2), mostly (score = 3), and always

(score = 4). All scores were summed up and multiplied by the number of items (10 items), where higher scores indicate poor cognitive performance.

3.5 Statistical Analysis

Descriptive statistics were used to describe the different characters of the participants of the study. Moreover, analysis of variance and independent t-test were performed to test the difference between the two sample means (shift workers vs. non-shift workers), given that stress, sleep quality, and cognitive performance are the dependent variables. All analysis was computed using SPSS 27.

4. Results

4.1 Shift and Non-shift workers Demographic Information

Descriptive statistics regarding age groups, gender, and rank among shift workers and non-shift workers are presented separately in Table 2. Furthermore, age group is divided into five subgroups which are age 18-24 given the value of 1, 25-34 given the value of 2, 35-44 given the value of 3, 45-54 given the value of 4, and 55-64 given the value of 5. Whereas gender is either male (value of 1), or female (value of 2). Rank is divided into 4 subgroups which are Civilians (value of 1), Policeman (value of 2), 1st Policeman – 1st Warrant Officer (value of 3), and Lieutenant – General (value of 4). Table 2 illustrates the descriptive statistics of the sample data.

Table 2. Descriptive statistics

Shift Status	Category	N	Mean	Std. Deviation	Skewness	
					Statistic	Std. Error
Shift	Age Group	152	2.41	.825	.191	.197
	Gender	152	1.01	.114	8.630	.197
	Rank	152	3.10	.698	-.137	.197
Non-shift	Age Group	155	2.68	.939	-.026	.195
	Gender	155	1.17	.375	1.796	.195
	Rank	155	3.22	.750	-.852	.195

4.2 Test of the Effect of Different Factors on the Sample Data

In order to ensure that the different age groups, gender, or rank have no impact on the test variables, ANOVA analysis was done to compare the stress, sleep quality, and cognitive performance means of the different age groups, and different rank classes as shown in Table 3. Given that the null hypothesis is that the mean of the different age groups is equal, and the alternative hypothesis is that they are not equal.

$$H_o = \mu_{Age\ 18-24} = \mu_{Age\ 25-34} = \mu_{Age\ 35-44} = \mu_{Age\ 45-54} = \mu_{Age\ 55-64}$$
$$H_1 = \mu_{Age\ 18-24} \neq \mu_{Age\ 25-34} \neq \mu_{Age\ 35-44} \neq \mu_{Age\ 45-54} \neq \mu_{Age\ 55-64}$$

Sum of squares, degrees of freedom (df), mean square, and F value are utilized to calculate the level of significance of the difference between the different groups. The significance level is set to 0.05 and any value equal to or less than 0.05 ($\propto \leq 0.05$) is considered to be significant. As illustrated in Table 3 in terms of stress, sleep quality and cognitive performance the significance level is less than 0.05 which means that age group has no effect on the sample means. In terms of police rank, ANOVA was also conducted such that:

$$H_o = \mu_{Civil\ Servants} = \mu_{\text{Policeman}} = \mu_{\text{1st Policeman – 1st Warrant Officer}} = \mu_{Officers}$$
$$H_1 = \mu_{Civil\ Servants} \neq \mu_{\text{Policeman}} \neq \mu_{\text{1st Policeman – 1st Warrant Officer}} \neq \mu_{Officers}$$

Given the level of significance from Table 3, the level of significance is less than 0.05 in all three measured values, thus there's no difference in mean between the different rank classes and it has no effect on the sample means.

Table 3. ANOVA analysis comparing means of age groups and rank classes in relation to the three measured values

Age Group	Value measured	Range of analysis done	Sum of Squares	df	Mean Square	F	Sig.

	Stress Score	Between Groups	2.975	4	.744	1.939	.104
	Sleep Quality Score	Between Groups	2.811	4	.703	1.778	.133
	Cognitive Performance Score	Between Groups	3.350	4	.837	.866	.485
Rank Classes	Stress Score	Between Groups	.415	3	.138	.354	.786
	Sleep Quality Score	Between Groups	.971	3	.324	.810	.489
	Cognitive Performance Score	Between Groups	1.647	3	.549	.566	.638

In order to study if gender had any effect on the sample means T-test was utilized to compare between males and females. According in Levene's test for equality of variances which assumes that the two sample means have equal variances and the level of significance should be greater than 0.05 in this case. As shown in Table 4, Levene's test significance level is greater than 0.05 in terms of stress, sleep quality, and cognitive performance. Thus, referring to the equal variances assumed row in Table 4, the conducted t-test using t value and df to calculate the level of significance, it can be concluded that the difference between males and females mean is insignificant.

Table 4. T-test comparing gender means in relation to the three measured values

	Value measured	Range of analysis done	Levene's Test for Equality of Variances		t-test for Equality of Means		
			F	Sig.	t	df	Sig. (2-tailed)
Gender	Stress Score	Equal variances assumed	.493	.483	-.492	305	.623
		Equal variances not assumed			-.531	33.865	.599
	Sleep Quality Score	Equal variances assumed	1.106	.294	-.760	305	.448
		Equal variances not assumed			-.805	305	.623
	Cognitive Performance Score	Equal variances assumed	3.586	.059	-.508	33.865	.599
		Equal variances not assumed			-.646	305	.448

4.3 The Association between Shift Work and Stress, Sleep Quality, and Cognitive Performance

Since neither gender, age group, nor rank had any correlations with the testing variables. Test of equal variances (Levene's Test) of shift and non-shift workers is done. Results show that in all three variables the variation is significant as shown in table 5. Therefor the null hypothesis of equal variances is rejected and the assumption of homogeneity of variances is violated.

$$H_o = \sigma^2_{shift} = \sigma^2_{non-shift}$$

$$H_1 = \sigma^2_{shift} \neq \sigma^2_{non-shift}$$

Therefore, referring to t-test results where equal variances is not assumed, the difference in means between shift and non-shift workers is found to be very close to significant ($\propto = 0.083 > 0.05$), therefore null hypothesis of equal means is accepted, and shift work has no effect on stress levels among Sharjah Police officers.

$$H_o = \mu_{shift} = \mu_{non-shift}$$
$$H_1 = \mu_{shift} \neq \mu_{non-shift}$$

In the case of testing equal means between shift and non-shift workers in terms of sleep quality, it is considered to be of high significance ($\propto = 0.005 < 0.05$), thus shift work has an effect on officer's quality of sleep. Furthermore, the relationship between shift work and cognitive performance is considered to be insignificant ($\propto = 0.493 > 0.05$), therefore the null hypothesis of equal means is rejected, and it cannot be concluded that there's an association between shift status and cognitive performance.

Table 5. Shift vs Non-shift workers t-test in relation to the three measured values

		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
Stress Score	Equal variances assumed	5.187	.023	1.737	305	.083
	Equal variances not assumed			1.739	299.728	.083
Sleep Quality Score	Equal variances assumed	5.224	.023	2.835	305	.005
	Equal variances not assumed			2.830	294.710	.005
Cognitive Performance Score	Equal variances assumed	5.340	.022	.687	305	.492
	Equal variances not assumed			.686	293.203	.493

4.4 The Association between Shift Status and Sleep Quality

The difference in participants results between shift and non-shift workers is significant. It is necessary to study the type of association between those two variables. In terms of the number of minutes required to fall asleep, both shift and non-shift workers show high percentages in number of participants spending greater than 60 minutes to sleep (63 out of 155 non-shift workers (40.6%) whereas 64 out of 152 shift workers (42.1%)) as shown in Figure 1. Moreover, a higher percentage of non-shift workers (32.26%) spend less than 15 minutes to fall asleep compared to shift workers (19.7%).

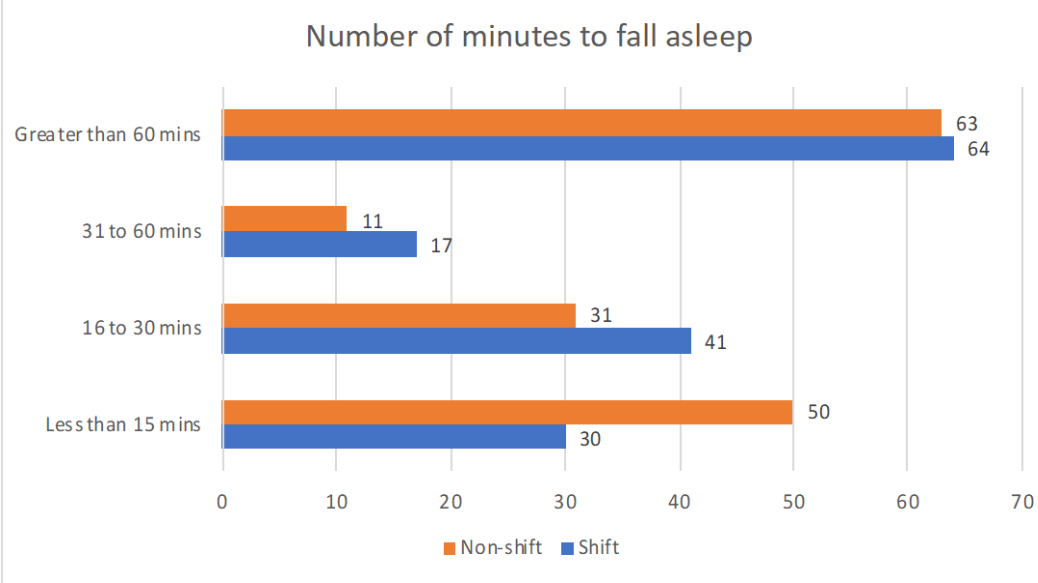

Figure 1. Shift workers vs non-shift workers number of minutes to sleep

The percentage of officers getting more than 7 hours of sleep is very small regardless of the shift work status (14.8% non-shift workers and 17.7% shift workers) as shown in Figure 2. A percentage of 33.5% of non-shift workers get 6 to 7 hours of sleep per night while 22.3% of shift workers get the same amount of sleep. 32.9% of shift workers get less than 5 hours of sleep per night whilst 24.5% non-shift workers get less than 5 hours.

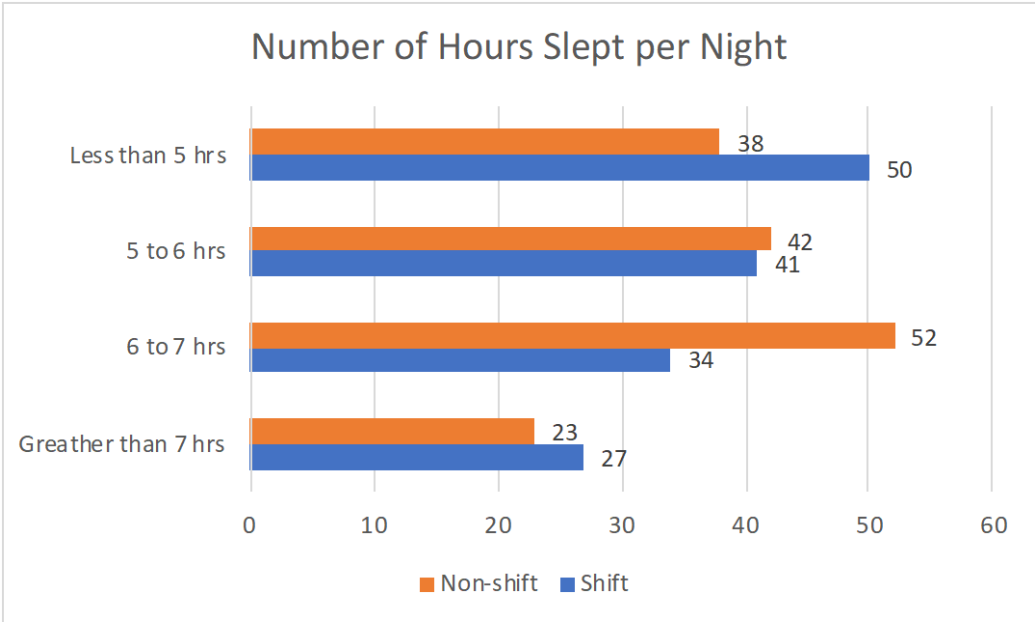

Figure 2. Shift workers vs non-shift workers number of hours of sleep per night

Shift worker's mean ($\mu = 1.444$) as illustrated in Table 6. is higher than non-shift workers mean ($\mu = 1.241$) advocating that shift work is associated with poorer sleep quality.

Table 6. Shift vs non-shift sleep quality means

	Shift / Non shift	N	Mean	Std. Deviation
Sleep Quality Score	Shift	152	1.444	.675
	Non-shift	155	1.241	.570

5. Conclusion

This study presented the relationship between shift work and stress, sleep quality, and cognitive performance among Sharjah Police officers. In the present study, the association of shift work and stress severity in the past three months was examined using Spielberger Police Stress Survey. As well as the association of shift work and sleep quality in the past three months using PSQI. Cognitive performance (in the past three months) and shift work association was also tested. Results have shown that shift work is only associated with poorer sleep quality among officers. It can be concluded that shift work has no effect on stress levels among Sharjah Police officers, while it cannot be concluded that there's an association between shift status and cognitive performance. Further future research should be carried out to investigate why the influence of sleep poorer quality in the current studied sample - if taken as an independent factor – has no significant influence on both stress and cognitive performance as may usually be expected (Alhola and Polo-Kantola P. 2007, Bendak and Rashid 2020). An early explanation can be highlighted as the overall elevated positive organizational culture and technology-empowered work environment, which can help reduce work stresses and support better cognitive performance respectively.

All three measured variables as well as shift work information were all obtained utilizing self-reporting method which involves a high risk of bias. Objective measures could be utilized to study stress, sleep quality, and cognitive performance along with the subjective self-reporting. Furthermore, a comparison between different shift rosters can be conducted in order to differentiate between the impact of each roster in order to help shift managers to set an optimum shift schedule that will increase productivity and reduce health risks. Moreover, further analysis of covariate such as gender, rank, and age might have an effect on the correlation between shift work and the other variables.

References

Åkerstedt, T., and Wright, K. (2009). Sleep Loss and Fatigue in Shift Work and Shift Work Disorder. *Sleep Medicine Clinics*, *4*(2), 257-271.

Alhola P and Polo-Kantola P. (2007) Sleep deprivation: impact on cognitive performance. *Neuropsychiatr Dis Treat*;3(5):553e67.

Annunziata, M., et al. (2012). Cognitive functioning self-assessment scale (CFSS): Preliminary psychometric data. *Psychology, Health & Medicine*, *17*(2), 207-212.

Bendak, S., and Rashid H. (2020), Fatigue in aviation: A systematic review of the literature. *International Journal of Industrial Ergonomics* 76:102928.

Boivin, D., et al. (1996). Dose-response relationships for resetting of human circadian clock by light. *Nature*, *379*(6565), 540-542.

Buysse, D., et al. (1989). The Pittsburgh sleep quality index: A new instrument for psychiatric practice and research. *Psychiatry Research*, *28*(2), 193-213.

Chang, Y., et al. (2011). Impairment of perceptual and motor abilities at the end of a night shift is greater in nurses working fast rotating shifts. *Sleep Medicine*, 12(9), 866-869.

Collins, P., and Gibbs, A. (2003). Stress in police officers: a study of the origins, prevalence and severity of stress-related symptoms within a county police force. *Occupational Medicine*, 53(4), 256-264.

Darvishi, E., et al. (2014). Evaluation of effective factors on occupational stress in firefighting personnel. *Journal Of Health System Research*, 11(1), 184-192.

Drake CL and Wright KP Jr. (2011) Shift Work, Shift Work Disorder, and Jet Lag. *In M.H. Kryger, T. Roth, W.C. Dement (Eds). Principles and Practice of Sleep Medicine*. (Fifth Edition). 784-798.

Drake, C., and Wright, K. (2011). Shift Work, Shift-Work Disorder, and Jet Lag. *Principles And Practice Of Sleep Medicine*, 784-798.

Drake, C., et al. (2004). Shift Work Sleep Disorder: Prevalence and Consequences Beyond that of Symptomatic Day Workers. *Sleep*, *27*(8), 1453-1462.

Durmer, J., and Dinges, D. (2005). Neurocognitive Consequences of Sleep Deprivation. *Seminars In Neurology*, 25(01), 117-129.

Farias, S., et al. (2008). The measurement of everyday cognition (ECog): Scale development and psychometric properties. *Neuropsychology*, *22*(4), 531-544.
Garbarino, S., et al. (2011). Police job strain during routine activities and a major event. *Occupational Medicine*, 61(6), 395-399.
Gerber, M., et al. (2010). The relationship between shift work, perceived stress, sleep and health in Swiss police officers. *Journal Of Criminal Justice*, 38(6), 1167-1175.
Gerber, M., et al.. (2010). The relationship between shift work, perceived stress, sleep and health in Swiss police officers. *Journal Of Criminal Justice*, *38*(6), 1167-1175.
Guo, Y., et al. (2013). The Effects of Shift Work on Sleeping Quality, Hypertension and Diabetes in Retired Workers. *Plos ONE*, *8*(8), e71107.
Guyette, F., et al. (2012). The Effect of Shift Length on Fatigue and Cognitive Performance in Air Medical Providers. *Prehospital Emergency Care*, *17*(1), 23-28.
Haus, E., and Smolensky, M. (2013). Shift work and cancer risk: Potential mechanistic roles of circadian disruption, light at night, and sleep deprivation. *Sleep Medicine Reviews*, *17*(4), 273-284.
Hobfoll, S. E. (1998). Stress, culture, and community. The psychology and philosophy of stress. *New York: Plenum Press*.
Horne, J. (2007). *Sleepfaring: A Journey Through the Science of Sleep*. Oxford University Press.
Horrocks, N., and Pounder, R. (2006). Working the night shift: preparation, survival and recovery - a guide for junior doctors. *Clinical Medicine*, 6(1), 61-67.
Karatsoreos, I. (2012). Effects of Circadian Disruption on Mental and Physical Health. *Current Neurology and Neuroscience Reports*, 12(2), 218-225.
Karlsson, B., et al. (2001). Is there an association between shift work and having a metabolic syndrome? Results from a population based study of 27 485 people. *Occupational And Environmental Medicine*, *58*(11), 747-752.
Kecklund, G., et al. (2008). Police officers attitude to different shift systems: Association with age, present shift schedule, health and sleep/wake complaints. *Applied Ergonomics*, *39*(5), 565-571.
Killgore WD. (2010) Effects of sleep deprivation on cognition. *Prog Brain Res*; 85:105e29
Lai, D., et al. (2020). A graph-based formulation for the shift rostering problem. *European Journal Of Operational Research*, *284*(1), 285-300.
Lamport, D., et al. (2016). Concord grape juice, cognitive function, and driving performance: a 12-wk, placebo-controlled, randomized crossover trial in mothers of preteen children. *The American Journal Of Clinical Nutrition*, 103(3), 775-783.
Ma, C., et al. (2015). Shift Work and Occupational Stress in Police Officers. *Safety And Health At Work*, *6*(1), 25-29.
Ma, C., et al. (2019). Influence of Work Characteristics on the Association Between Police Stress and Sleep Quality. *Safety And Health At Work*, *10*(1), 30-38.
Magnavita, N. (2000). Industrial mass psychogenic illness: The unfashionable diagnosis. *British Journal Of Medical Psychology*, 73(3), 371-375.
McCAFFERTY, F., et al. (1992). Stress and Suicide in Police Officers. *Southern Medical Journal*, 85(3), 233-243.
Minors, D., et al. (1991). A human phase-response curve to light. *Neuroscience Letters*, *133*(1), 36-40.
Mohr, D., et al. (2003). The Mediating Effects of Sleep in the Relationship Between Traumatic Stress and Health Symptoms in Urban Police Officers. *Psychosomatic Medicine*, *65*(3), 485-489.
NHANES III - Examination Data File. Wonder.cdc.gov. (2020). Retrieved from https://wonder.cdc.gov/wonder/sci_data/surveys/hanes/hanes3/type_txt/exam1.asp.
Proctor, S., et al. (1996). Effect of overtime work on cognitive function in automotive workers. *Scandinavian Journal Of Work, Environment & Health*, *22*(2), 124-132.
Prunier-Poulmaire, S., et al. (1998). Combined effects of shift systems and work requirements on customs officers. *Scandinavian Journal of Work Environment and Health*, 24, 134−140
Richardson, K., and Rothstein, H. (2008). Effects of occupational stress management intervention programs: A meta-analysis. *Journal Of Occupational Health Psychology*, 13(1), 69-93.
Richbell, S., and Chan, K. (2011). Permanent night shifts in the 24/7 economy. *University Of York. The York Management School*, (1743-4041), 61.
Rosenblum, S., et al. (2017). Development of the Daily Living Questionnaire (DLQ): A Factor Analysis Study. *The Open Journal Of Occupational Therapy*, *5*(4).
Spielberger, D., et al. (1981). The police stress survey: sources of stress in law enforcement. *University Of South Florida. Human Resources Institute,* 3(6).
Tamagawa, R., et al. (2007). Tolerance of shift work. *Applied Ergonomics*, *38*(5), 635-642.

Taylor, Y., et al. (2019). The Effects of Fatigue on Cognitive Performance in Police Officers and Staff During a Forward Rotating Shift Pattern. *Safety And Health At Work*, *10*(1), 67-74.

Toglia, J., et al. (2020). Cognitive Self-Efficacy in Parkinson's Disease (PD). *American Journal Of Occupational Therapy*, *74*(4_Supplement_1), 7411505257p1.

Torsvall, L., et al. (1989). Sleep on the Night Shift: 24-Hour EEG Monitoring of Spontaneous Sleep/Wake Behavior. *Psychophysiology*, 26(3), 352-358.

Violanti, J, et al. (2008). Shift-work and suicide ideation among police officers. *American Journal Of Industrial Medicine*, *51*(10), 758-768.

Wardle-Pinkston, S., et al. (2019). Insomnia and cognitive performance: A systematic review and meta-analysis. *Sleep Medicine Reviews*, *48*, 101205.

Willis, T., et al. (2008). Investigating effort–reward imbalance and work–family conflict in relation to morningness–eveningness and shift work. *Work & Stress*, *22*(2), 125-137.

Wright, K., et al. (2013). Shift work and the assessment and management of shift work disorder (SWD). *Sleep Medicine Reviews*, 17(1), 41-54.

Yazdi, Z., et al. (2014). Prevalence of Sleep Disorders and Their Impacts on Occupational Performance: A Comparison between Shift Workers and Nonshift Workers. *Sleep Disorders*, *2014*, 1-5.

Biographies

Bushra Almheiri is a master's student in Engineering Management in the department of Industrial Engineering and Engineering Management at University of Sharjah, UAE. Bushra earned B.S. in Industrial Engineering and Engineering Management in 2018 from University of Sharjah. She is currently working as a Quality Officer in the Strategy and Performance Development Department at Sharjah Police Headquarters.

Hamad Rashid is an Assist. Professor, an aeronautical engineer and a PhD in engineering management holder in the field of industrial safety and accident investigations. Professionally, he is a certified chartered aircraft accident investigator, a lead auditor of the international standard ISO-10015 for quality in higher and vocational education, a member of the Royal Aeronautical Society-UK, and a fellow of the Higher Education Academy – UK. He is experienced consultant engineer and skilled academic with records of achievements in engineering consultancies, teaching, and research. These are manifested through 31 years of experience in aeronautical engineering, engineering systems safety, risk management, quality, performance enhancement, leadership and innovation, teaching and supervision of research at the post graduate level with strong focus towards UK and worldwide industry.