Cardiovascular health, stress and sleep of shift working police officers: A physiological assessment

Jaymen Luke Elliott

BMedSc (Hons)

2017

Principal supervisor: Associate Professor Sara Lal (UTS)

Alternate supervisors: Doctor Najah Nassif (UTS)

Professor Phillip Newton (WSU)

Submitted in partial fulfilment of the requirements for the degree of Doctorate of Philosophy (Science) at the University of Technology Sydney.

"Quis custodiet ipsos custodes?"

(Satires VI, lines 347 – 348) – **Juvenal**

The woods are lovely, dark and deep,
But I have promises to keep,
And miles to go before I sleep,
And miles to go before I sleep.
"*Stopping by Woods on a Snowy Evening*" – **Robert Frost**

Declaration

Certificate of original authorship.

I certify that the work in this thesis has not been previously submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text. This research was supported by an Australian Government Research Training Program Scholarship.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Production Note:
Signature: Signature removed prior to publication.

Date: 13th of December, 2017

Jaymen Luke Elliott

Acknowledgments

The completion of this thesis has been the greatest and most personal undertaking of my academic career, and I know that without the following people it would not have been possible. It is to them that I owe my deepest gratitude:

- Associate Professor Sara Lal; your guidance, wisdom and understanding have been irreplaceable these past five years. I will never be able to repay the opportunity you've given me, but I take pride in knowing our research will benefit so many people. It has been a pleasure under your tutelage and I hope to continue collaborating with you in future endeavours.
- School of Life Sciences, University of Technology Sydney (UTS) (including my co-supervisors Dr. Najah Nassif and Dr. Phillip Newton); for providing a nurturing and intellectually stimulating environment to conduct my research. By exploring new concepts and imparting critical analytical skills, I am confident I will continue to represent UTS and its values as an ethical researcher.
- The Neuroscience Research Unit, particularly Taryn Chalmers and Ty Lees; this accomplishment is one we share, borne from a competitive friendship spanning nearly a decade. Misery loves company, and I couldn't be more thankful for the company I have kept. And to all of Sara's disciples, thank you for keeping me grounded and always inspiring me to be a better colleague and role model.
- NSW Police Force and Police Association of NSW, particularly Dr. Christopher Devery; for recruitment of the police officers and liaising with the different LAC's. The insight you offered into the occupation of policing was immeasurable, and I hope this study seeks to achieve our shared goal of ensuring the safety and wellbeing of the police officers serving in Australia. Most importantly, I would like to extend my sincere gratitude to the fine men and women of the NSW Police Force who were involved in this study and who persevere at their own risk to protect our society.
- My family and friends, particularly my fiancée Robert Swift; your infinite love and patience has been the greatest motivator in achieving this thesis. I look forward to celebrating with you all and embracing our futures together.

List of Figures

List of Tables

Table of Contents

List of Abbreviations

ANOVA = Analysis of Variance

BMI = Body Mass Index

BP = Blood Pressure

C = Constable

CFS = Chronic Fatigue Syndrome

CIS20 = Checklist of Individual Strength

CVD = Cardiovascular Disease

DBP = Diastolic Blood Pressure

ESS = Epworth Sleepiness Scale

FSS = Fatigue Severity Scale

HPA = Hypothalamic-Pituitary-Adrenal (Axis)

HREC = Human Research Ethics Committee

HSD = Honestly Significant Difference

LAC = Local Area Command

LAQ = Lifestyle Appraisal Questionnaire

MANCOVA = Multivariate Analysis of Covariance

mmHg = Millimetres Mercury

n/c = No Change

NSW = New South Wales

PC = Probationary Constable

PSQI = Pittsburgh Sleep Quality Index

PTSD = Post-Traumatic Stress Disorder

SBP = Systolic Blood Pressure

SC = Senior Constable

SCN=Suprachiasmatic Nucleus

SD = Standard Deviation

Sgt = Sergeant

SNS = Sympathetic Nervous System

SOS = Survey of Shiftworkers

TTW = Total Travel to Work (Time)

UTS = University of Technology Sydney

WCQR = Ways of Coping Questionnaire (Revised)

WHR = Waist-Hip Ratio

> = Greater than

≥ = Greater than or equal to

< = Less than

≤ = Less than or equal to

List of publications and presentations

List of publications:

Elliott, J.L. & Lal, S. (2016) Blood pressure, sleep quality and fatigue in shift working police officers: Effects of a twelve hour roster system on cardiovascular and sleep health. *International Journal of Environmental Research and Public Health*, **13** (2), 1-8.

Singh, S., **Elliott, J.L.**, Wyndham, J. & Lal, S. (2016) Associations between lifestyle risk factors, coping and cardiovascular health in police officers. *PLoS One* (Pending)

Lees, T., **Elliott, J.L.**, Gunning, S., Newton, P., Rai, T. & Lal, S. (2017) A review of current evidence about mental disorders and psychological and other wellbeing programs in the law enforcement workplace. *Safety & Health at Work* (Presented in Court; Pending)

List of conference presentations:

Elliott, J.L. & Lal, S. Blood pressure and fatigue links to shift work in police officers of NSW. *Oral Presentation*: 29th Combined Health Science Conference (November 2012 – Sydney, Australia).

Elliott, J.L., Lees, T., Nassif, N. & Lal, S. Cardiovascular measures and sleep health associations with shift work in police officers: a physiological assessment. *Oral Presentation*: 31st Combined Health Science Conference (November 2014 – Sydney, Australia).

Singh, S. **Elliott, J.L.**, Wyndham, J. & Lal, S. Heart rate variability association to stress and coping ability in police officers. *Oral Presentation*: 31st Combined Health Science Conference (November 2014 – Sydney, Australia).

Kalatzis, D., **Elliott, J.L.** & Lal, S. Investigating blood glucose levels and fatigue in NSW police officers: Implications for metabolic disorders. *Oral Presentation*: 32nd Combined Health Science Conference (November 2015 – Sydney, Australia).

Elliott, J.L., Lees, T., Nassif, N. & Lal, S. Poor sleep quality and fatigue in shift working police officers: Effects of a 12 hour roster system on cardiovascular and sleep health. *Oral Presentation*: 9th International Conference on Managing Fatigue (March 2015 – Perth, Australia)

Elliott, J.L., Lees, T., Nassif, N. & Lal, S. Stress and the New South Wales Police Force: The prevalence of various coping mechanisms. *Oral Presentation*: 2nd Interuniversity Neuroscience & Mental Health Conference (September 2015 – Sydney, Australia)

Abstract

Police officers have been reported to experience a high incidence of chronic health issues (Kales et al., 2009; Hartley et al., 2011), which present prematurely in an otherwise healthy population (Bonneau & Brown, 1995; Barron, 2010). Shift work has also been associated with an increased prevalence of cardiovascular, stress and sleep disorders (Åkerstedt & Wright, 2009; Pan et al., 2011; Jermendy et al., 2012; Zimberg et al., 2012; Hamta et al., 2017), attributed primarily to its propensity for circadian rhythm dysfunction (Shen et al., 2006; Gamble et al., 2011). However, contention exists as to whether shift work has a direct effect upon blood pressure (BP) regulation (Hublin et al., 2010; Sfreddo et al., 2010; Ohlander et al., 2015). The present study explores the associations between shift work and the stress, sleep and cardiovascular health of general duties police officers, as well as comparing within subgroups based on sex, shift and occupational rank.

Recruited participants were added to an existing database (Elliott & Lal, 2016) (n=100) to produce a total sample of N=255 general duties police officers. Endorsed by the New South Wales (NSW) Police Force and Police Association of NSW, observations were made across nine Local Area Commands in a cross-sectional model. The experimental protocol involved BP measurements, taken before and after their regular twelve hour shift, in combination with a comprehensive questionnaire battery. Participants completed the following tools, including the Lifestyle Appraisal Questionnaire (Craig et al., 1996), Epworth Sleepiness Scale (Johns, 1991), Pittsburgh Sleep Quality Index (Buysse et al., 1989), Checklist of Individual Strength (Vercoulen et al., 1994), Fatigue Severity Scale (Krupp et al., 1989), Ways of Coping Questionnaire (Folkman et al., 1986) and Survey of Shiftworkers (Folkard et al., 1995).

Systolic BP was found to significantly increase ($p<0.05$) after shift work for the total sample, female officers, senior constables and police working a day shift, although these changes were relatively small. A substantial number of significant associations were also identified with BP, even after accounting for the covariates of age, sex, waist-hip ratio and lifestyle risk factors. Subjects' perception of stress was within normal ranges for the majority, likely due to the significant associations found with preferable coping style prevalence. By comparison, poor sleep quality and severe fatigue was found to

predominate within the sample, almost irrespective of sex, shift or occupational rank. Finally, many significant differences were also found amongst police officers when compared between the aforementioned subgroups.

Based on these initial findings, further insight has been made into the detrimental effects shift work may have upon the cardiovascular and sleep health of individuals. Future research must incorporate more physiological measurements, as well as assess the efficacy of suggested interventional programmes which seek to ameliorate fatigue and bolster coping mechanisms. Not only would this reduce potential accidents and associated costs for the NSW Police Force, but most importantly also improve the occupational health and safety of the global shift working community at large.

Chapter 1 Introduction

Police work to maintain the peace and uphold the laws of our society. Although policing is often romanticised, it is an inherently stressful occupation (Cooper et al., 1982; Dantzer, 1987; Brown & Campbell, 1990), in which 80% of a constable's time involves investigating crimes, responding to emergency calls and patrolling known criminal areas (Achterstraat, 2007). In Australia, there are different police forces that operate on a state-wide basis, with 16,627 police officers serving in New South Wales (NSW) as of 2016 (NSW Police Force, 2016).

The occupational health of police officers worldwide has been thoroughly researched as evident in current literature. Between 2015 and 2016, the determinable loss of NSW general duties police officers totalled 404 persons, 76% of whom were constables, as shown in Figure 1.1 (NSW Police Force, 2016). The typical officer's lifestyle involves extended periods of inactivity, sporadically interrupted by unpredictable events of high physical demand (Kales et al., 2009), long work hours, reduced sleep and organisational stressors (Vila & Kenney, 2002; Shane, 2010) all of which contribute to an increased risk of workplace injury and civil liability damages (Senjo, 2011; Violanti et al., 2012).

Emotional stressors (Vila & Kenney, 2002) and occupational hazards (van Kempen et al., 2002; Attarchi et al., 2012) have also been indicated by police officers' presentation of hypervigilance, absenteeism and worker's compensation claims (Mayhew, 2001a; Kirschman, 2006). Further concerns have been raised with healthy individuals recruited into the police and exhibiting subsequent rapid health declinations after recruitment (Bonneau & Brown, 1995; Barron, 2010). Police have also been found to have an increased risk of developing a great number of different chronic health issues (Brown & Trottier, 1995; Kales et al., 2009; Hartley et al., 2011), including post-traumatic stress disorder (PTSD) (Carlier et al., 1997), fatigue (Vila & Kenney, 2002; Senjo, 2011), depression (Kutlu et al., 2005), suicide (Violanti et al., 2008; Barron, 2010), as well as cardiovascular disease (CVD) and various cancers (Vena et al., 1986; Brown & Trottier, 1995; Kales et al., 2009).

Figure 1.1 – Police officer losses for NSW between 2015 and 2016

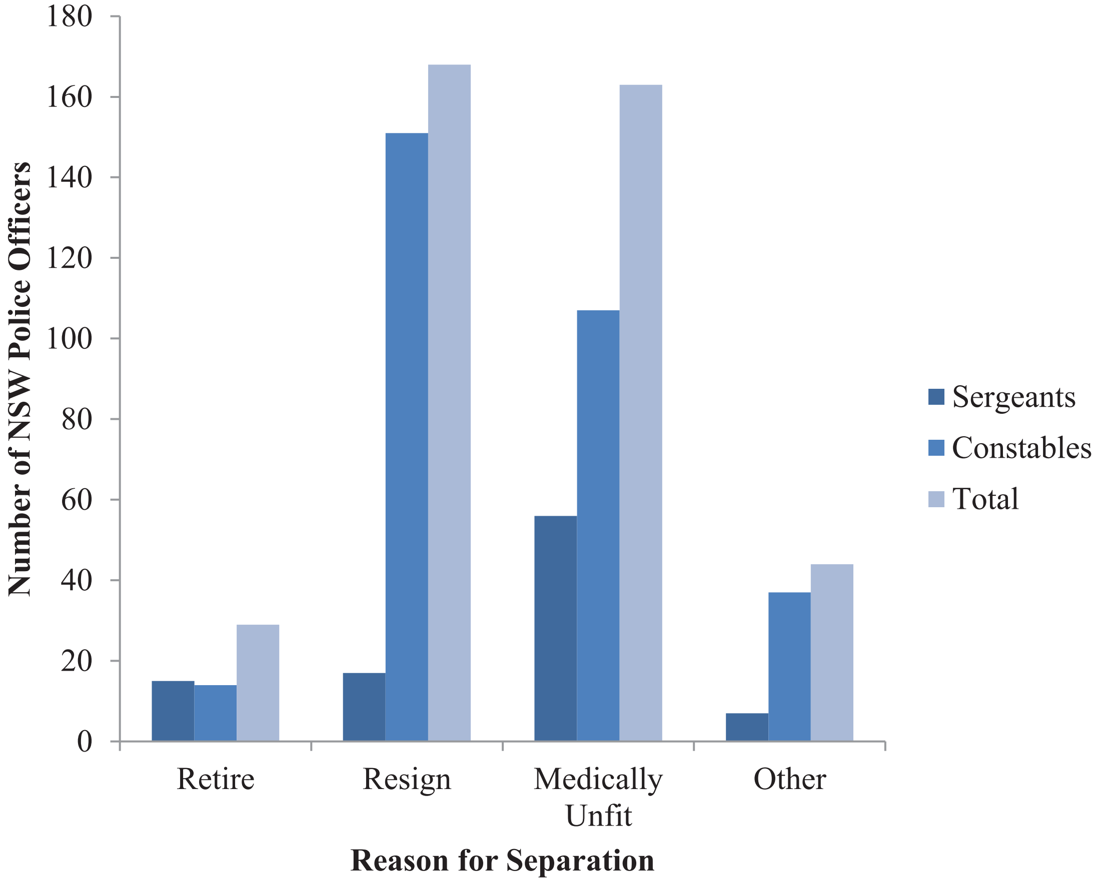

Figure 1.1 shows the loss of NSW Police Force general duties police officers for the 2015 and 2016 period. The total values used also include constables and sergeants, while senior and executive officers are excluded. Constables comprised 14 of 29 total officers who retired and 151 of 168 who had resigned. Those officers who retired or resigned due to medical grounds were also listed as medically unfit, with 107 constables of a total 163 being deemed as such. Other reasons for separation included death, annulment of appointment, disengagement, termination of contract, transfers and voluntary redundancy. Image adapted from NSW Police Force, (2016), page 84.

In 2010 there were 1.4 million shift workers employed in Australia, constituting approximately 16% of all employees (Pink, 2010). Shift work typically involves the rostering of people outside of the usual eight hour workday (9am – 5pm) (Bøggild & Knutsson, 1999; Costa, 2003). In today's 24-hour operational society, the ability to provide efficient service at all hours is a necessity (Harrington, 2001). Shift work may benefit the employee by reducing necessary travel time to and from work, while also allowing longer rest days (Moore-Ede et al., 2010). This frees the shift worker to pursue secondary employment, also known as "moonlighting", although concerns have been raised regarding the risks of extended work periods (Motohashi & Takano, 1993; Bendak, 2003). Considerable effort has been made to determine optimal shift working conditions (Knauth, 1993; Knauth, 1995), however there is no consensus in the literature on the length, speed or orientation of shift rotation that should be employed for optimal work and health balance (Orth-Gomer, 1983; Lavie et al., 1992; Smith et al., 1998; Hesselink et al., 2010).

There is an established body of evidence that shows the deleterious effects of shift work (Shen & Dicker, 2008; Gerber, Hartmann, et al., 2010). Although there exists suggestions of shift work tolerance and adaptability (Andlauer et al., 1979; Eastman, 1990), it has been shown to significantly increase levels of fatigue (Rajaratnam et al., 2011; Yuan et al., 2011), which is an impaired ability to continue activity that negatively influences performance due to sleep loss (Winwood et al., 2006; Moore-Ede et al., 2010). Concerns have also been raised regarding the propensity for circadian rhythm disruption (Motohashi et al., 1987; Scheer et al., 2009; Ferreira et al., 2012), due to prolonged daily activities, which is believed to expose shift workers to an increased risk of health issues such as hypertension (Morikawa et al., 1999; Sakata et al., 2003; Suwazono et al., 2008), CVD (Kawachi et al., 1995; Knutsson et al., 1999; Puttonen et al., 2009), various cancers (Conlon et al., 2007; Haus & Smolensky, 2013) and other metabolic disorders (van Amelsvoort et al., 1999; Suwazono et al., 2009; Pan et al., 2011; Buxton et al., 2012). Although improved shift work structure and design have been suggested to ameliorate associated risks (Knauth, 1993; Knauth, 1995), there remains considerable contention as to whether these cardiovascular risks can even be attributed directly to shift work (Di Lorenzo et al., 2003; Hublin et al., 2010; Lieu et al., 2012). The increased prevalence of these morbidities can severely impact upon employee performance and sick leave (Fekedulegn et al., 2013), which is of major concern for all occupations, especially policing, where constant alertness and decision-making are essential to avoid personal or public injury (Lindsey, 2007; Senjo, 2011; Violanti et al., 2012).

Previous studies have explored the field of shift work and its ramifications on health (Åkerstedt, 2003; Costa, 2003), as well as the cardiovascular and occupational hazards faced by police officers, but few have identified links between shift work and its effect on blood pressure (BP). Fatigue is often attributed to shift work, so increased prevalence should indicate adverse rostering conditions, which can lead to stress and cardiovascular diseases such as hypertension. Hence the relevance of the current study was to identify changes in police officers' BP, stress levels and sleep health attributable to shift work.

1.1 Police Officers

Police officers' service to society is irreplaceable, often involving the handling of tragic and extreme events to actively reduce crime and fear (NSW Police Force, 2016). To handle these potentially hazardous situations they must remain professionally composed (Pogrebin & Poole, 1991), however cynicism and emotional ambivalence have been found to be direct consequences of prolonged emotional suppression (Kirschman, 2006).

Policing is often viewed as a highly satisfying occupation, while also creating an exclusive fraternity for officers (Lindsey, 2007). However, employment as a police officer is not a particularly lucrative profession, with the starting salary reported to be $65,000 per annum in Australia (NSW Government, 2017). For this reason, police officers often pursue voluntary overtime for monetary gain (Vila, 2006). Opportunities like this must be curbed for the safety of the officer who may be overexerting themselves (Mayhew, 2001a; Senjo, 2011), reflected in their strict rostering models. The NSW Police Force operates under 'flexible rostering guidelines' (Lauer, 1995), although a governmental audit found the majority of general duties police officers to be working 'block' twelve hour shifts (Achterstraat, 2007).

Originally, NSW police officers were able to work shifts varying in length from six to twelve hours, with alternating start and finish times, and a maximum of two consecutive 12 hour night shifts (Lauer, 1995). However, it was found that many departments were not honouring these requirements and had even implemented 12 hour "block rosters", as shown in Table 1.1, with some officers working upwards of four consecutive 12 hour shifts (Achterstraat, 2007). Most police officers preferred this system which gave them the liberty to work at another occupation during their rest days. This "moonlighting" allows police officers to work beyond conventional occupational hours, recognised generally as greater than 48 hours of work per week (Harrington, 2001). One officer was even found to be approved to work 30 hours per week in the mining industry in addition to their primary occupation; this is of major concern as it has been found that long working hours can increase the risk of cardiovascular attacks in middle-aged workers (Uehata, 1991). Collectively, the combination of an insular culture, potentially precarious financial status and limited decisional latitude with respect to their working hours makes police officers a vulnerable population requiring further research. Although it is essential to employ police officers at all hours due to the nature of crime, there are a myriad of risks associated with working under a shift work system.

Table 1.1 – A typical twelve hour 'block' NSW police roster

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Officer 1	12 hours	12 hours	12 hours	12 hours	Rest	Rest	Rest
Officer 2	12 hours	12 hours	12 hours	12 hours	Rest	Rest	Rest
Officer 3	Rest	Rest	12 hours	12 hours	12 hours	12 hours	Rest
Officer 4	Rest	Rest	12 hours	12 hours	12 hours	12 hours	Rest
Officer 5	Rest	Rest	Rest	Rest	12 hours	12 hours	12 hours
Officer 6	Rest	Rest	Rest	Rest	12 hours	12 hours	12 hours
Officer 7	12 hours	12 hours	Rest	Rest	Rest	Rest	12 hours
Officer 8	12 hours	12 hours	Rest	Rest	Rest	Rest	12 hours

Day Shift (6:00 to 18:30)	Night Shift (18:00 to 6:30)	Rest Day

Table 1.1 provides an example of a twelve hour 'block' roster utilised for NSW police officers. The roster includes a 30 minute turn-over period for police officers beginning and ending their shift and shows a minimum 3 day rest period for consecutive 12 hour shifts, which is typical for NSW. Image adapted and modified from Achterstraat, (2007), page 20.

1.2 Shift Work

The creation of the electric light bulb by Thomas Edison allowed the modern work force to cater to the demands of a perpetually active society (Haus & Smolensky, 2013). Shift work is the method used by emergency services, among many other occupations, to provide sufficient numbers of personnel at all hours of the day (Harrington, 2001). Any work undertaken outside the typical eight hour work day, with the intent of spanning all 24 hours, can constitute shift work (Åkerstedt et al., 1984; Costa, 2003). With 16% of the Australian work force employed as shift workers (Pink, 2010), there is an extensively reviewed body of research which highlights concerns attributed to the practice (Driscoll et al., 2007; Shen & Dicker, 2008; Saksvik et al., 2011b; Vogel et al., 2012). Specific characteristics of shift work believed to influence the magnitude of associated adverse health effects include the length, speed and direction of shift rotation (Orth-Gomer, 1983; Lavie et al., 1992; Knauth, 1993; Hesselink et al., 2010). However, the primary concerns with respect to shift work are its propensity to disrupt natural sleep and circadian rhythm cycles (Kales et al., 2009) (see Section 1.2.1), which in turn may lead to multiple health issues, including CVD (Dominguez-Rodriguez et al., 2009; Lieu et al., 2012).

1.2.1 Circadian Rhythms

Circadian rhythms are an endogenous 'biological clock' which dictates the fluctuations in physiological activity of diurnal mammals (Laposky et al., 2008). Located within the hypothalamus is a collection of neurons named the suprachiasmatic nucleus (SCN), which is responsible for entraining our bodies to the repetitive sequence of day and night (Lewy et al., 1980; Myers & Badia, 1995). Interestingly, it has been found that most people 'free-run' with a circadian day length of approximately 25 hours (Eastman, 1990). The sleep-wake cycle is one of the most important functions, dictating when an individual must rise for daily function or fall asleep for recuperation (Stokowski, 2012). Figure 1.2 shows the changes in body temperature, hormone synthesis and release (including cortisol, melatonin and catecholamines), as well as rates of metabolism that are influenced by circadian cycles (Åkerstedt, 2003; Monk, 2005; Laposky et al., 2008).

Figure 1.2 – Physiological factors influenced by circadian rhythms

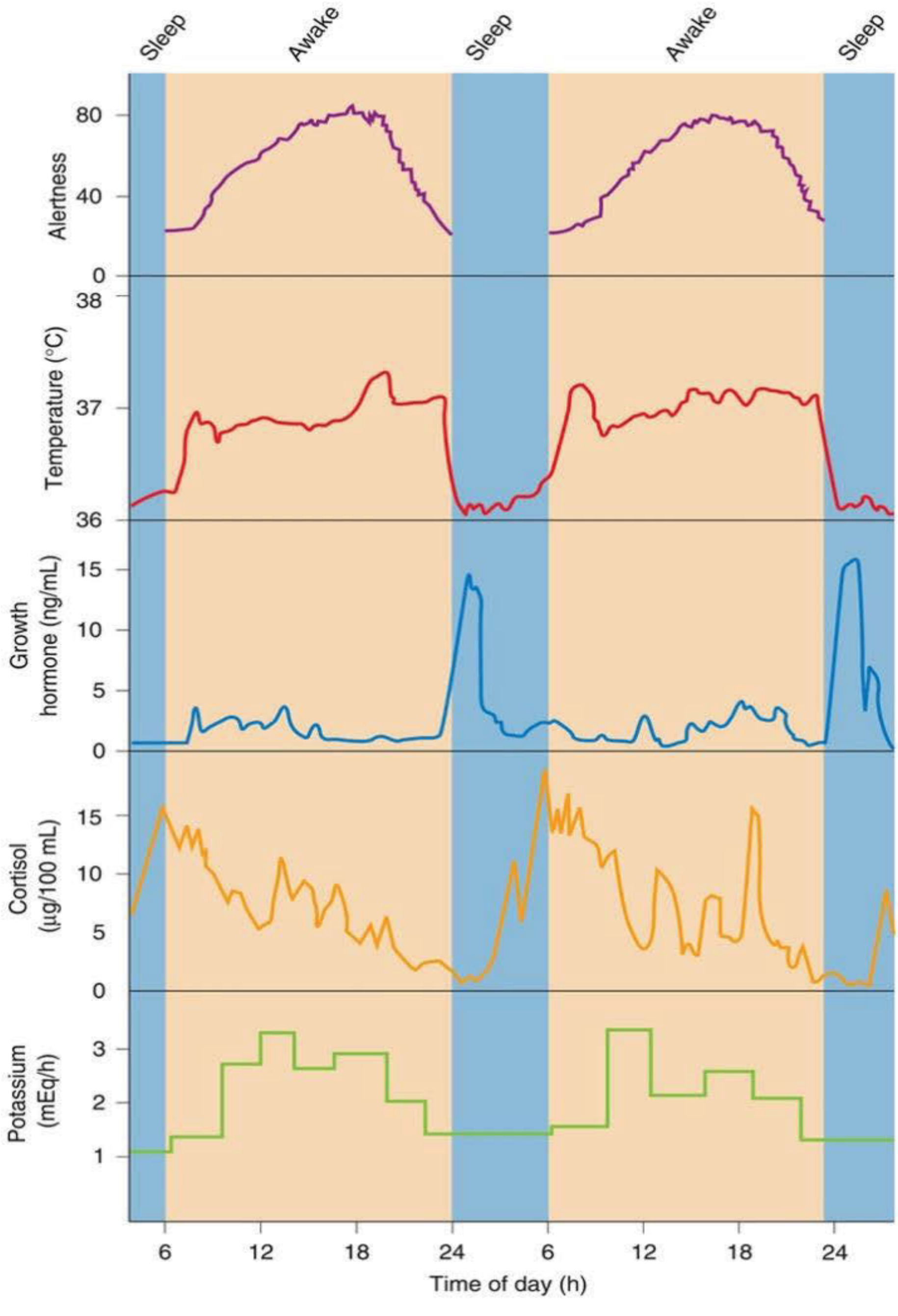

Figure 1.2 shows different physiological features which fluctuate between arousal and sleep due to natural circadian rhythms. As alertness decreases due to light cues, body temperature drops as declinations in metabolic activity occur. Without the causative stressors experienced during wakefulness, the body's cortisol levels also decrease. Growth hormone increases during sleep to initiate development and repair while potassium excretion rates drop due to termination of urine output. Image adapted from Bear et al., (2007), page 608.

Key: °C = degrees Celsius, h = hour, µg/100mL = micrograms per 100 millilitres, mEq/h = milliequivalents per hour, ng/mL = nanograms per millilitre

Although there exist gradual changes in circadian function during the course of the day (Burgess & Fogg, 2008; Brown et al., 2011), and as humans age (Härmä et al., 1990; Myers & Badia, 1995), shift work has also been found to directly disrupt the body's natural circadian rhythms (Motohashi et al., 1987; Ferreira et al., 2012). A number of studies have identified changes in female shift workers' menstrual cycles (Baker & Driver, 2007). The combination of longer work hours, reduced sleep volume, as well as significantly lower levels of melatonin and prolactin, are believed to be responsible for the increased incidence of menstrual cycle dysfunction (Miyauchi et al., 1992; Labyak et al., 2002; Shao et al., 2010). However, many authors suggest shift work has no significant effect upon pregnancy rates or subfecundity in shift working females (Tuntiseranee et al., 1998; Zhu et al., 2003; Bonzini et al., 2011).

Of specific concern to this study is the regulation of arousal and BP. The body prepares for rest by releasing the hormone melatonin (see Section 1.2.2) from the pineal gland when stimulated by environmental cues of decreasing light intensity (Lewy et al., 1980; Myers & Badia, 1995). Synchronised with this is the body's drop in catecholamine levels, thereby lowering BP approximately 15 – 20 mmHg between 8pm and 2am (Shiel, 2012). However, shift work often requires individuals to continue activity outside normal daily parameters which can lead to desynchronisation from the body's circadian rhythms (Shen et al., 2006; Gamble et al., 2011) and hence disrupt BP regulation. 'Chronodisruption' is the term used to describe the desynchronisation of an individual from their natural circadian rhythms (Stokowski, 2012). This is of concern as the propensity of shift work to adversely affect circadian rhythms is evidenced by an increased incidence of metabolic disorders (Lin et al., 2009; Pan et al., 2011; Buxton et al., 2012; Zimberg et al., 2012) and changes in hormone levels (Touitou et al., 1990; Scheer et al., 2009), potentially contributing to the estimated 75% of emergency responders defined as overweight or obese (Kales et al., 2009).

Despite this evidence, there are many proponents that suggest individuals may possess inherent 'shift work tolerance' (Andlauer et al., 1979; Härmä, 1993). Folkard et al., (1979) found in a sample of night-shift nurses (n=48) that flexibility of sleeping habits, ability to overcome drowsiness and morningness/eveningness disposition were able to distinguish individuals. Similarly, in a population of New Zealand police officers (n=89), flexibility of sleeping habits was again a factor of influence (Tamagawa et al., 2007), however tolerance of shift work was also associated with anxiety, repressive emotional behaviour and mood. Age and gender have also been found to strongly influence an individual's ability to tolerate shift work (Oginska et al., 1993), although contention remains as to whether age facilitates or impedes this function (Härmä, 1996; Shen & Dicker, 2008). Further, based on jet-lag studies, it has been suggested that circadian rhythms can be readjusted or adapted to accommodate shift work (Boivin & James, 2002; Åkerstedt, 2003; Kolla & Auger, 2011). Similar to shift work tolerance, Gamble et al., (2011) found an individual's sleep strategy and chronotype to influence adaptation, while others suggest it may take upwards of five days to re-establish baseline patterns (Deacon & Arendt, 1996) or that complete adaptation is rarely achieved (Eastman, 1990). This may be due to exposure to unnatural light sources during sensitive phases of the circadian cycle (Czeisler et al., 1986), with dim light and bright light soliciting different physiological responses (Badia et al., 1991). However, only very bright light of about 2500 lux will elicit this effect (Lewy et al., 1980), and with indoor light rarely over a fifth of that (Thorington, 1985), it does not account for the high inter-individual variability with respect to tolerance and adaptability to shift work (Costa, 2003; Axelsson et al., 2004; Saksvik et al., 2011b). Finally, these studies notwithstanding, sleep disturbances and fatigue remain a significant concern for all shift workers (Drake et al., 2004; Shen et al., 2006; Yuan et al., 2011), due to the attributable decrements in sleep quantity and quality (Kales et al., 2009).

1.2.2 Sleep & Fatigue

Sleep is a state of diminished consciousness, initiated by the body's circadian rhythms (Stokowski, 2012), whereby interaction with environmental stimuli is severely limited (Åkerstedt, 2006). It is broadly accepted that the primary function of sleep is restitution (Horne, 1978), with individuals circulating through four to six cycles of different sleep stages (Lindsey, 2007). Most people require eight hours of sleep per night (Dinges et al., 1988), although this period increases for the young and decreases for the elderly (Tepas et al., 1993; Van Cauter et al., 1998; Ferrara & De Gennaro, 2001). The hormone melatonin is responsible for the entrainment of the light-dark cycle in humans (Myers & Badia, 1995), inducing transient drowsiness and lowering body temperature so as to prepare for rest (Arendt, 1998). Synthesised by the pineal gland (Moore, 1978), the daily cycling of melatonin is influenced by the SCN and conforms to endogenous circadian rhythmicity (Lewy et al., 1980; Pandi-Perumal et al., 2007), however exposure to artificial light, hormonal birth control and reduced sleep quantity have been shown to alter these natural rhythms (Zeitzer et al., 2000; Burgess & Fogg, 2008), as shown in Figure 1.3 (EPG Health Media Ltd, 2012).

Figure 1.3 – Fluctuations in melatonin levels over a 24-hour period

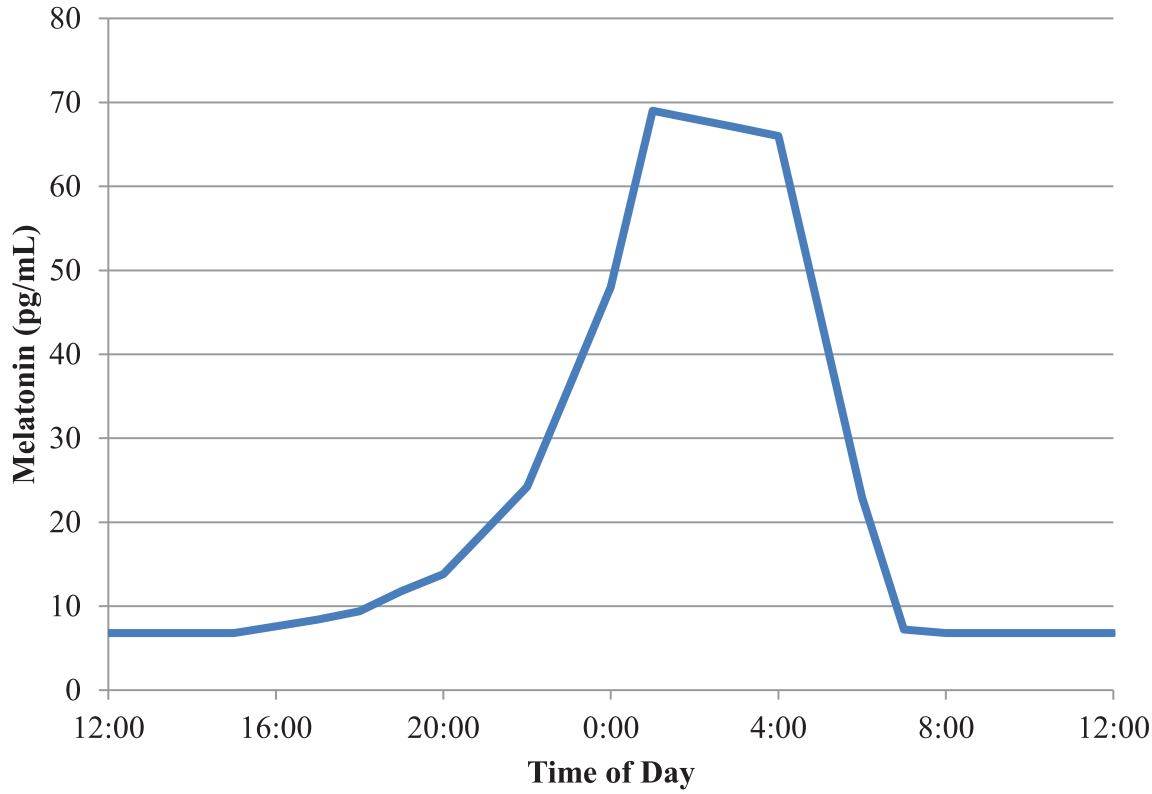

Figure 1.3 shows the daily plasma levels of circulating melatonin. As the pineal gland begins producing melatonin, concentrations rise to peak around midnight, before returning to low levels maintained throughout the day. Image adapted from EPG Health Media Ltd, (2012).

Key: pg/mL = picograms per millilitre

Shift work has been shown to significantly increase subjective fatigue levels (Shen et al., 2006; Yuan et al., 2011; Kazemi et al., 2016), which remains a significant risk associated with policing (Vila et al., 2000; Vila & Kenney, 2002; Vila, 2006). Shift Work Sleep Disorder, a circadian rhythm sleep disorder (Sack et al., 2007; Kolla & Auger, 2011) suggested to affect 10% of the shift working population (Drake et al., 2004), is of particular concern due to its associated fatigue and general disorientation (Costa, 2003). This is compounded by the typically hazardous occupation of policing (Violanti et al., 2012), and could account for the 60% increase in unintentional sleep in night shift workers (Åkerstedt et al., 2002). This is supported by Sallinen et al., (2003) who also found that in their cohort of train drivers and traffic controllers (n=230) up to 50% reported dozing off during their night shift. Therefore, it is the combination of shift work and reduced sleep among police officers that can lead to compromised public safety and civil liability damages (Senjo, 2011), most of which are associated with increased levels of fatigue.

There is currently no consensual definition for fatigue, instead often being used synonymously with sleepiness, which may occur due to the two pathologies' frequent coexistence and similar symptomatic presentation (Pigeon et al., 2003). Several authors have sought to separate the two conditions, citing their independent manifestation in different sleep disorders (Hossain et al., 2005), and for this study they will be viewed as separate entities to conform with the majority of relevant literature (Shen et al., 2006). Sleepiness refers to an individual's propensity to fall asleep and can be considered pathological if it persists at inappropriate times (Shahid et al., 2010). By comparison, psychological fatigue is a state in which an individual's capacity to initiate or continue performing any task is diminished (Brown, 1994; Moore-Ede et al., 2010), which does not essentially imply the typical tendency to fall asleep associated with daytime sleepiness (Hossain et al., 2005), and will be the definition employed in this study. Fatigue results in feelings of weariness and apathy, evidenced by depressed mood and motivation (Lindsey, 2007), while both fatigue and sleepiness have also been frequently associated with an increased occurrence of occupational accidents (Dinges, 1995; Van Dijk & Swaen, 2003; Suzuki et al., 2004). The risk this poses to police officers, and consequently the greater community, has lead researchers to consider the ideal structure and design of shift work systems (Knauth, 1993; Knauth, 1995).

1.2.3 Shift Design

Shift work is a necessity in our modern age (Harrington, 2001), particularly in emergency services, despite the great deal of evidence detailing its associations with adverse health effects (Gordon et al., 1986; Arendt, 2010). However, there is an abundance of literature which has sought to identify favourable ergonomic designs for shift work. Although there is no optimum shift system (Knauth, 1993), there are preferable ones with respect to the length, speed and orientation of shift rotation, which have all been found to influence employees' wellbeing (Knauth, 1995).

Logic dictates that extended periods of activity, outside of regular work hours, will increase likelihood of generating fatigue (Motohashi & Takano, 1993). Despite this, the most common lengths for shift work are either 8 or 12 hours (Smith et al., 1998). The latter offers a myriad of benefits to the employer, including increased productivity with reduced absenteeism (Moore-Ede et al., 2010), while employees report improved quality and duration of rest periods for their social and filial obligations (Loudoun, 2008). However, this prolonged exposure to occupational stressors, in conjunction with an inflexible sleep schedule, has been suggested to increase driver fatigue while heading home and may result in sleep deficits (Karlson et al., 2009). A large number of studies have sought to identify the ramifications of implementing 12 hour shifts (Bendak, 2003), and while some report persistent decrements in alertness (Ognianova et al., 1998), their overwhelming popularity with shift workers often mars the associated concerns (Rosa, 1991). Similar to the NSW Police Force (Lauer, 1995), a 12 hour roster was implemented in a cohort of Melbourne nurses (n=37), and it was found there were minimal changes to employee well-being and work performance, whilst also being greatly preferred by staff (Campolo et al., 1998).

Opportunities to compare 8 and 12 hour length shift work often present when organisations attempt changes in their roster model. In a longitudinal study of control-room operators at a continuous processing plant, Rosa et al., (1989) observed increased subjective fatigue and poorer test performance after the implementation of a 12 hour shift when compared to the original 8 hour system. Even at 10 months post intervention, the same issues persisted (Rosa & Bonnet, 1993), however the shift system became permanent after 80% of employees voted to retain the new schedule (Rosa & Colligan, 1992). In a similar cohort of power plant workers (n=31), sleepiness was higher and physical effort lower in 12 hour workers, although there were no significant differences in total sleep volume or performance between workers (Axelsson et al., 1998). By comparison, sleep quality and quantity, as well as subjective alertness, were all found to improve in a group of police officers after the change from an 8 hour/12 day cycle to 12 hour/8 day roster (Peacock et al., 1983). Overall, it would appear there are minimal differences with regards to 8 and 12 hour shift length (Vik & MacKay, 1982; Smith et al., 1998), but caution should be taken depending on the speed and direction of shift rotation if choosing to implement shifts greater than 10 hours (Knauth, 1993).

In the context of shift work, the 'speed of rotation' refers to the number of consecutive shifts of the same type (Knauth, 1995), and can either be considered 'slow' (≥3 same shifts) or 'rapid' (≤2 same shifts). Although there are proponents of permanent shift work schedules (Phillips et al., 1991), citing their improved circadian adaptability (Eastman, 1990), the inflexible nature of such a roster limits occupations and hence the need for rotating shift work. In two independent studies, a group of Dutch railway traffic controllers (n=85) (Ng-A-Tham & Thierry, 1993) and emergency service shift workers (n=33) (Williamson & Sanderson, 1986) both found significant improvements in sleep quality and quantity after the transition from a slow to rapidly-rotating shift schedule. In a more recent study, Hesselink et al., (2010) also found improvements in employees' fatigue, musculoskeletal complaints and workload a year after changing to fast shift rotation at a large steel producer (n=4600). However, their results may also have been due to the additional change from backward to forward rotating shifts (Hesselink et al., 2010), which has been argued to influence shift workers' wellbeing greater than speed of rotation (Czeisler et al., 1982).

The orientation of shift rotation is believed to influence the extent to which circadian rhythm disruption, attributable to shift work, will affect an individual's wellbeing (Knauth, 1995). When discussing the direction of rotation, shifts can either be forward/'phase delaying' (e.g. morning-afternoon-night) or backward/'phase advancing' (e.g. night-afternoon-morning) (Barton et al., 1994). In a group of British industrial and service shift workers (n=261), it was found that those who remained on an advancing roster had more domestic disruption, lower job satisfaction and poorer physical and mental health when compared to their phase delayed-oriented peers (Barton & Folkard, 1993). This is further supported by van Amelsvoort et al., (2004) who found shift workers on backwards rotation exhibited worse general health and a greater need for recovery (n=681), while those working in forward direction (n=95) showed less work-family conflict, as well as improved sleep quality on 32 months follow-up. By comparison, Knauth & Hornberger, (1998) found no significant differences for sleep duration, incidence of sleep disturbances or general health between two groups of shift workers, although over 95% voted in favour of the new forward-rotating shift model. Similarly, in a cohort of rapidly rotating industrial shift workers (n=611), chronic measures of health and wellbeing were unable to identify significant differences amongst advanced or delayed employees (Tucker et al., 2000). In summary, efforts should be made by employers to ensure favourable length, speed and direction of rotation if considering shift work, as the generated sleep dysfunction and fatigue due to circadian misalignment has also been associated with various stress disorders (Meerlo et al., 2008; Gerber, Hartmann, et al., 2010).

1.3 Stress & Cortisol

Stress may be defined as any stimulus, real or imagined, which disrupts the homeostatic balance of an individual, thereby requiring a response (Harris et al., 2009). Distress is the term used to describe the negative physiological or psychological stress placed upon the body by which it must exceed its own energy capacity to maintain homeostasis (Le Fevre et al., 2003), and this instigates the ‘fight-or-flight’ response. First described by Cannon, (1932), the fight-or-flight response prepares the body to deal with the stressor and is regulated by the hypothalamic-pituitary-adrenal (HPA) axis (Habib et al., 2001), as shown in Figure 1.4 (Bear et al., 2007). This involves both the endocrine and autonomic nervous systems, initiated by the release of corticotropin-releasing hormone by the hypothalamus into the pituitary gland, which in turn releases adrenocorticotropic hormone which enters the systemic circulation that elicits the release of cortisol from the adrenal cortex (Matteri et al., 2000). There is also an increase in sympathetic nervous system activity (Axelrod & Reisine, 1984), due to the release of catecholamines (epinephrine, norepinephrine and dopamine), which elevates heart rate and cardiac output, while also depressing non-vital physiological functions, so as to flee or overcome the initial stressor (Cannon, 1932). However, should a stressor be chronic in nature, there is prolonged secretion of cortisol which has been found to lead to various deleterious health effects, including a depressed immune response and hippocampal atrophy (Arnsten, 1998; Lindauer et al., 2006; Akinola & Mendes, 2012). Although cortisol secretion has been found to exhibit an endogenous cycle due to the body’s natural circadian rhythms (Pruessner et al., 1997; Harris et al., 2010), there remains concerns about the potential for exacerbation of the stress response when coupled with shift work (Touitou et al., 1990; Manenschijn et al., 2011), as well as the inherently stressful occupation of policing (Neylan et al., 2005; Pineles et al., 2013).

Figure 1.4 – The hypothalamic-pituitary-adrenal axis during a stress response

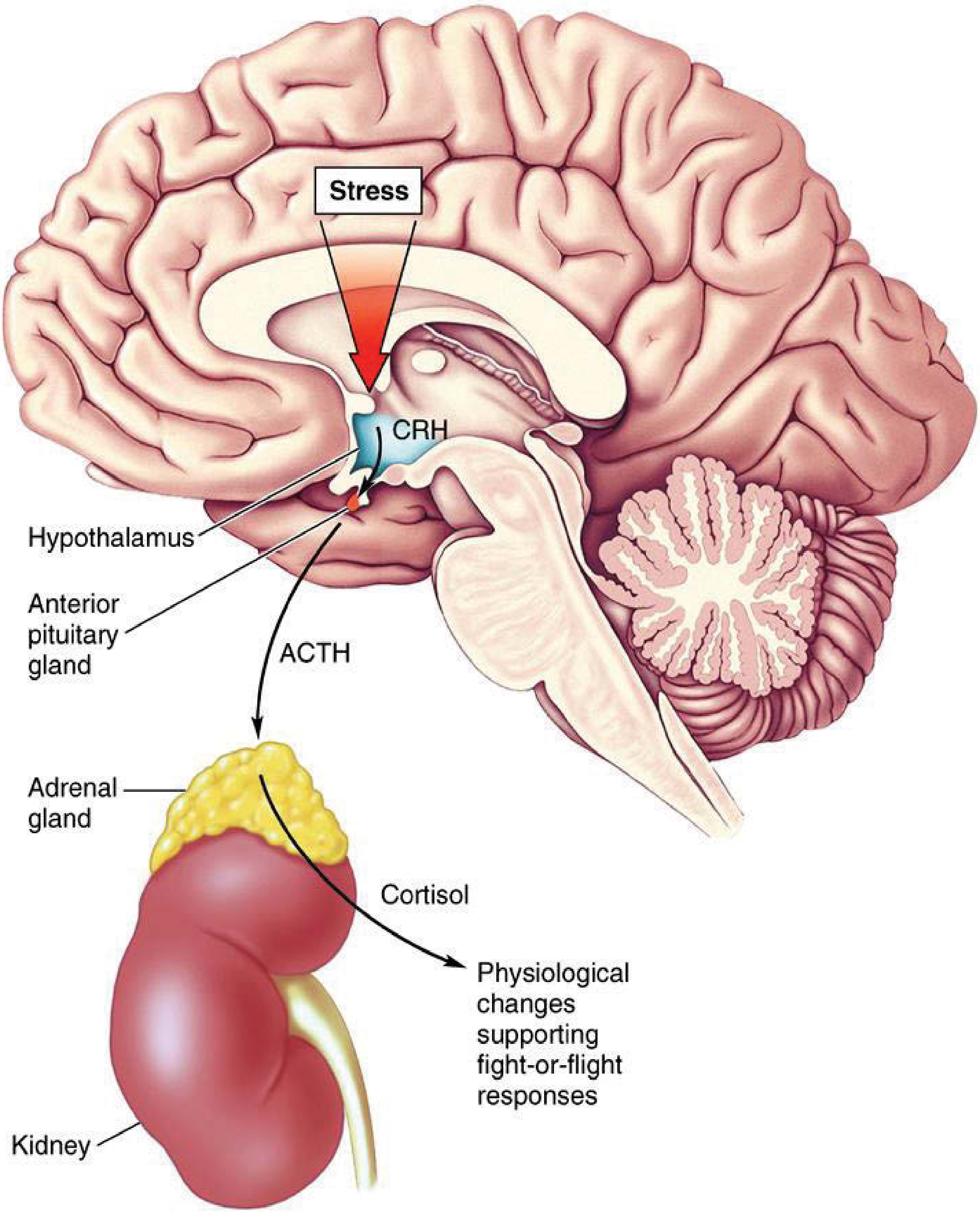

Figure 1.4 shows the hypothalamic-pituitary-adrenal axis responding to a stressful stimulus. To initiate a response to the stressor, the hypothalamus releases CRH into the anterior pituitary gland. This leads to the release of ACTH into the systemic circulation which instigates release of cortisol from the adrenal glands situated above the kidneys. This results in physiological changes to combat the stressor in what is known as the "fight or flight" response. Image adapted from Bear et al., (2007), page 668.

Key: ACTH = Adrenocorticotropic Hormone, CRH = Corticotropin-Releasing Hormone

There are conflicting results as to the effect shift work may have on an individual's cortisol rhythms, with some authors suggesting an overall increase (Manenschijn et al., 2011; Nakajima et al., 2012), others suggesting a decrease (Touitou et al., 1990; Wirth et al., 2011), or even no significant changes (Hennig et al., 1998; Harris et al., 2010). This may be due in part to the various methods of cortisol assessment, such as the sample source (including hair, saliva, urine or blood) (Vining et al., 1983; Kirschbaum & Hellhammer, 1994; Garde & Hansen, 2005), as well as the time point during the circadian cycle at which the sample was obtained, typically immediately after awakening (Pruessner et al., 1997). The concern with shift work is the associated deficits in sleep quantity and quality, with both sleep deprivation and primary insomnia shown to influence cortisol rhythms (Backhaus et al., 2004; Åkerstedt, 2006).

By comparison, the potential associations between cortisol fluctuations, policing and PTSD have been more conclusive (Carlier et al., 1997). PTSD sufferers have been found to have a reduced hippocampal volume (Lindauer et al., 2004), generalised white matter atrophy (Villareal et al., 2002), as well as higher cortisol levels upon awakening (Lindauer et al., 2006). Although some police officers with increases in cortisol exhibit improved decision making (Akinola & Mendes, 2012), those with a higher mean awakening cortisol level have also presented with severe PTSD symptom clusters (Violanti et al., 2007), such as avoidance and hyperarousal (Neylan et al., 2002). This has been suggested to be due to the increased likelihood of a police officer being exposed to potentially traumatic events (Lilly et al., 2009; Pineles et al., 2013). Inslicht et al., (2011) even sought to determine whether the cortisol response of police recruits, without critical incident exposure (n=296), would dictate the likelihood of stress symptomology. After longitudinal assessment of subjects at 12, 24 and 36 months, it was found that a greater cortisol awakening response was a significant risk factor for acute stress disorders, but not PTSD (Inslicht et al., 2011). While the human body has adequate physiological processes to perceive and address a stressor (Cannon, 1932), policing imposes extraordinary sources of stress on an individual (Cooper et al., 1982; Brown & Campbell, 1990), which may be either inherent or occupational (Pendergrass & Ostrove, 1984; Perrier & Toner, 1984).

1.3.1 Police & Occupational Stress

Police officers experience a great deal of potential stressors, both anticipatory and unpredictable (Arnsten, 1998), in their efforts to maintain law and order. While the external sources and effects of police stress are obvious, including traumatic events and dealing with persistently negative attitudes from the media and general public (Perrier & Toner, 1984; Mayhew, 2001b), the internal 'occupational stress' could be considered even more insidious (Cox, 1978). Organisational stressors (Brown & Campbell, 1990), such as bureaucratic inconsistencies, intradepartmental conflicts and disillusionment with the legal system (Kirkcaldy et al., 1995; Violanti & Aron, 1995; Shane, 2010), can all have a profoundly, and chronically, negative effect upon a police officer's health. The 'job-strain model' proposed by Karasek, (1979) postulates that the psychological strain an individual endures is influenced not only by work stress, but also by the work environment in which they operate, and that those with 'low decision latitude and high job demands' will be less able to deal with these stressors. Shift work is also considered a source of occupational stress (Costa, 2003), due to the 'time pressure' generated to perform social and familial responsibilities in a condensed time frame (Harrington, 2001; Loudoun, 2008). Although only 7 – 17% of general duties police officers in NSW are approved for secondary employment (Achterstraat, 2007), almost 38% have been found to work overtime and extended hours (Pink, 2010), thus adding further time constraints to their already stressful occupation. While managerial programmes and improved support networks can partly mediate these stressors (Murphy, 1984; Finn, 1997), an individual's ability to cope must be adequate so as to ensure personal and occupational wellbeing (Loo, 1984).

1.3.2 Coping

Although the study of coping behaviours is often wrought with conceptual confusion (Roskies & Lazarus, 1980), 'coping' can be broadly defined as any conscious employment of cognitive or behavioural strategies which seek to diminish a perceived stressor (Lazarus & Launier, 1978). Any attempt at coping, whether successful or not, can be considered as an individual's means to address the source of their stress (Lazarus & Folkman, 1984). While there have been many theories on coping and physiological responses to stress (Monk, 1988), for the context of this study we will be using a coping model postulated by Anshel, (2000), as shown in Figure 1.5.

Figure 1.5 – A conceptual model for coping with police stress

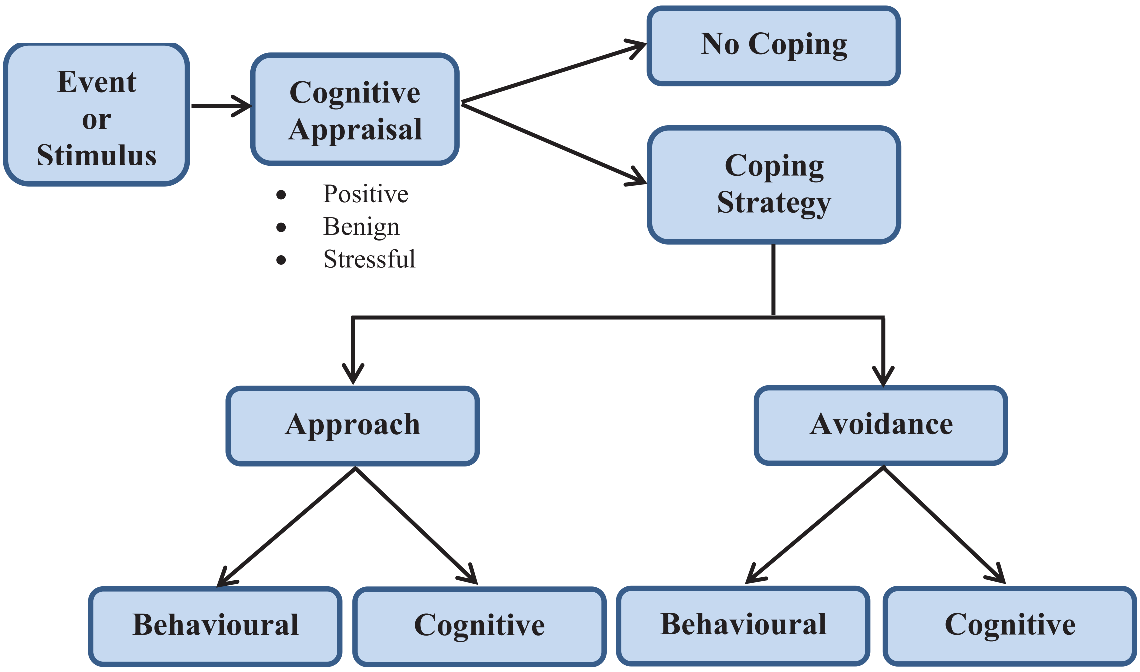

Figure 1.5 presents a theory on how police officers' cope with stress. After determining whether a potential stressor is positive, benign or stressful, an individual with either attempt coping or not. This will be either approach coping (directly reducing a stressful situation by seeking to control it) or avoidance (searching for a means of turning away from the source of stress), both of which can be either behavioural or cognitive. Behavioural approaches include Seeking Social Support, obtaining information or physical interventions, while cognitive approaches may involve rationalizing, analysing or planning. By comparison, cognitive avoidance can present as denial, humour or discounting the stressor, unlike behavioural avoidance which will be physically removing oneself from the source of stress. However, this last option can further be considered either adaptive (exercising, avoiding people/situations, etc.) or maladaptive (e.g. tobacco, alcohol or drug abuse). Image adapted from Anshel, (2000), page 382.

Firstly, a police officer must be able to determine whether a potential stressor is positive, benign or stressful, before choosing whether to cope. They will then commit to either approach (trying to overcome the stressor) or avoidance strategies (Anshel, 2000). Further, each option will either be behavioural (employing a more direct method) or cognitive (which is often more covert or indirect). Approach, or attentional, coping is more problem-focused and often leads to better adaptation in the long term (Suls & Fletcher, 1985), although its use is often only preferable when the source of stress is known and able to be overcome (Roth & Cohen, 1986). As police work stressors are often beyond an individual's control, there is a high prevalence of maladaptive cognitive avoidance (Richmond et al., 1998), usually through alcohol abuse (Violanti et al., 1985). Similar avoidance behaviours have also been exhibited by shift working nurses (n=111), which were also found to significantly predict incidence of chronic fatigue (Samaha et al., 2007). However, this is contested by Biggam et al., (1997), who found the majority of their cohort of Scottish police officers (n=699) employed direct, problem-focused coping strategies.

There appears to be minimal differences in coping when compared by gender (Alexander & Walker, 1994), however there are many influencing factors that can determine how well an individual will cope (Aldwin & Revenson, 1987), including personality factors such as 'hardiness' (Anshel, 2000). Kobasa, (1979) suggested hardiness is a mixture of commitment, control and challenge, and can be considered a personality trait which aide attempts at coping (Kobasa et al., 1982). This theory is supported by evidence of nurses suffering burnout due to having less hardiness than their peers (McCranie et al., 1987), as well as hardy police officers experiencing lower absenteeism, irrespective of self-perceived stress levels (Tang & Hammontree, 1992). However, hardiness does not appear to influence shift work tolerance (Bohle, 1997), and certainly cannot account for the high interindividual responses to stress among police populations. Only by considering the known physiological processes of stress perception, propagation and preferable responses via coping mechanisms discussed above can researchers hope to elucidate how policing organizations can better protect their officers. As has been shown, failing to acknowledge and deal with the inherently stressful aspects of the occupation exposes police officers to persistent stressors, thereby leaving them at greater risk of psychological and physical harms, including potentially deleterious effects on their cardiovascular system (Bøggild & Knutsson, 1999; Suwazono et al., 2008).

1.4 Blood Pressure & Shift Work

Blood pressure (BP) is used to describe the arterial pressure of circulating blood, with the unit of millimetres of mercury (mmHg) (Martini & Nath, 2009). The autonomic nervous system is responsible for the control of BP by maintaining cardiac output, peripheral resistance and blood volume through different physiological mechanisms including the renin-angiotensin-aldosterone system and the baroreceptor reflex (Bear et al., 2007). However, BP is also influenced by circadian rhythms (Shiel, 2012), as well as external factors such as ambient temperature, physical activity and sleep/wake cycle (Hermida et al., 2007). Associated with this is diurnal fluctuations in BP rhythms (Baumgart, 1991), evidenced by the natural 'dipping' of BP during the periods of 8pm and 2am (Carev et al., 2011) when many shift workers remain active. Hence these irregular working hours become a concern as they can disrupt circadian rhythms (Baumgart et al., 1989; Sherwood et al., 2002; Yadav et al., 2016; Yang et al., 2017), with a recent study in a large cohort of locomotive drivers (n=30,566) reporting that those working nights, as compared to day shifts, experience lesser declines in nocturnal BP (At'kov, 2012). As shown in Table 1.2, unabated increases in BP can lead to states of hypertension (National Heart Foundation of Australia, 2016).

Table 1.2 – Clinical blood pressure classifications for Australian adults

Blood Pressure Classification	Systolic Blood Pressure (mmHg)	Diastolic Blood Pressure (mmHg)
Optimal	< 120	≤ 80
Normal	120 – 129	80 – 84
High-Normal	130 – 139	85 – 89
Grade 1 (mild) Hypertension	140 - 159	90 - 99
Grade 2 (moderate) Hypertension	160 – 179	100 – 109
Grade 3 (severe) Hypertension	≥ 180	≥ 110
Isolated Systolic Hypertension	>140	<90

Table 1.2 shows the BP ranges necessary to constitute a diagnosis of hypertension. Due to the contractile forces of the heart, the maximum BP is systolic while the minimum is diastolic. To be considered "normal" an individual must have a BP of approximately 120-129/80-84mmHg. With increases in BP there is a danger of entering grade 1, 2 or 3 hypertension, which is also found to be associated with cardiovascular risks. Adapted from (National Heart Foundation of Australia, 2016), page 12.

Key: mmHg = Millimetres mercury, ≥ = Greater than or equal to, < = Less than, ≤ = Less than or equal to

Hypertension is a state of increased BP, generally accepted to be greater than 140/90mmHg (National Heart Foundation of Australia, 2016), and can significantly increase risk of adverse cardiovascular events such as myocardial infarction and stroke (Jermendy et al., 2012). In Australia, hypertension is the most common cardiovascular condition affecting 21.5% of the population over the age of 18 years (Australian Bureau of Statistics, 2013). There are risk factors, defined as either modifiable (such as smoking and diet) or non-modifiable (such as age, race and gender) which influence the likelihood of developing hypertension (Skarfors et al., 1991). With evidence for 75% of all emergency responders presenting with pre-hypertension or hypertension (Kales et al., 2009) and cardiovascular disease remaining the leading cause of death in developed countries (Bøggild & Knutsson, 1999), there is a growing concern for police officers' cardiovascular health due to BP alterations as a product of shift work (Tharkar et al., 2008).

The field of research governing the impact of shift work on cardiovascular function is vast but with inherent limitations. A Swedish study compared night shift workers who had a recent myocardial infarction (n=2,006) with normal day-working controls (n=2,642) and found an association between shift work and increased risk of myocardial infarction, although the causative mechanism could not be explained (Knutsson et al., 1999). Another similar study sought to determine the relationship between coronary heart disease and shift work in a cohort of female nurses (n=79,109) aged 42 to 67 years old (Kawachi et al., 1995). There was a significant increase in the risk of developing coronary heart disease in those nurses who had been working more than six years in shift work. By comparison, Bursey, (1990) found no conclusive evidence to support the theory that shift work has an adverse effect to potentiate the risk factors associated with coronary artery disease. Within their smaller sample of shift workers (n=57), who were age and lifestyle matched to an equal number of day worker controls, there were no statistically significant differences between the resting echocardiogram, cholesterol or BP levels amongst the two distinct samples (Bursey, 1990), which has added to the considerable contention regarding the hypothesised effect shift work may have upon BP regulation.

Among relevant scientific literature, the direct effect shift work may have upon BP regulation remains heavily contested, with some of the most recent and relevant studies summarised in Table 1.3. One study that involved a sample of Japanese shift workers (n=6,711) sought to determine whether BP increases with shift work (Suwazono et al., 2008). Using systolic blood pressure (SBP) and diastolic blood pressure (DBP) changes from baseline it was found there was a significant increase in BP among shift workers. Similarly, another study (n=481) used a combination of questionnaires and venous blood samples to determine whether there was an increased prevalence of hypertension among light industry and public service shift workers (Jermendy et al., 2012). Once again, the shift working men were found to have increased SBP. Yet another study compared 4 groups of rubber manufacturing shift workers (n=331) with varying degrees of noise exposure and shift schedules (Attarchi et al., 2012). In support of the previous studies, there was a significant relationship between simultaneous exposure to noise and shift work when comparing increases in SBP and DBP, as well as hypertension frequency. However, these findings may be explained by other studies (Rizk et al., 2016), including a meta-analysis which found that for every five decibel increase in occupational noise exposure there was a concurrent increase in SBP of 0.51mmHg (van Kempen et al., 2002). In another study involving a similar shift system to the NSW Police Force (Su et al., 2008), subjects (n=15) were found to experience persistent increases in SBP and DBP at night, as well as delayed cardiac recovery, although it is limited by a very small cohort of only male manufacturers. Some authors have even readdressed their initial studies' findings (Gholami-Fesharaki et al., 2014a; Gholami-Fesharaki et al., 2014b), retrospectively suggesting that shift work does have direct effects on BP regulation (Hamta et al., 2017). Finally, a very large sample of retired Chinese day and shift workers (n=26,463, average age of 63 years) were compared to identify the long-term potential BP altering effects of shift work (Guo et al., 2013). Shift workers were found to have a significantly elevated BP and fasting glucose, with the authors suggesting more frequent endothelial dysfunction and an overactive sympathetic nervous system as possible causative mechanisms.

Table 1.3 – Summary of relevant articles pertaining to shift work and blood pressure

Author/s	Sample Occupation	Shift System	Sex Ratio (M : F)	Blood Pressure
Di Lorenzo et al. (2003)	Chemical industry workers	Unclear: fixed day shift vs. three-shift rotating schedule (counter clockwise)	319 : 0	↑
Virkkunen et al. (2007)	Forestry manufacturers & engineers	Unclear: mix of fixed day shift, fixed night shift and two or three-shift rotating schedule	884 : 0	**n/c**
Su et al. (2008)	Semiconductor manufacturers	12hrs: two-shift schedule (day vs. night)	15 : 0	↑
Suwazono et al. (2008)	Steel manufacturers	8hrs: three-shift schedule (clockwise)	6,711 : 0	↑
Puttonen et al. (2009)	Shift workers (manual, non-manual or higher grade non-manual)	Unclear: mix of fixed day shift, two- or three-shift schedule	712 : 831	**n/c**
Sfreddo et al. (2010)	Nurses, nursing technicians & assistants	Unclear: three-shift system (fixed vs. rotating)	58 : 435	**n/c**
Attarchi et al. (2012)	Rubber manufacturers	8hrs: mix of fixed day shift, two-shift schedule, fixed evening shift and rotating shift	331 : 0	↑
Jermendy et al. (2012)	Light industry & public services	~8hrs: fixed day shift vs. rotating shift schedule	121 : 360	↑
Guo et al. (2013)	Retired manufacturers	Unclear; fixed day shift vs. rotating shift schedule	11,822 : 14,641	↑
Gholami-Fesharaki et al. (2014)	Steel manufacturers	8hrs: mix of fixed day shift, routinely rotating and weekly rotating (clockwise)	5,331 : 0	**n/c**
Ohlander et al. (2015)	Car manufacturers	8hrs: mix of fixed day, two-shift schedule, rotating shift schedule and fixed night shifts	22,817 : 2,526	↑
Choi et al. (2016)	Firefighters	24 hour shifts	321 : 9	↑

Table 1.3 summarises the different findings among the relevant literature with regards to shift work's hypothesised effects on BP. Presented in chronological order, these studies assessed widely varying samples sizes of shift working and non-shift working individuals who also differed in terms of age and occupational employment. Four studies found a direct increase in their subjects' BP levels attributable to shift work, while another deemed shift work as unrelated. By comparison, three studies found no significant change in BP due to shift work. When this collection of studies is compared, there is an obvious lack of unanimity and conclusive findings which further highlights the need for additional research in the field.

Key: BP = blood pressure, ↑ = increase in BP, n/c = no change in BP

By comparison, a notable collection of research exists that suggests shift work may have no significant impact on the incidence of CVD or elicit changes in BP. One longitudinal study, undertaken between 1982 and 2003, sought to identify the associations between shift work and CVD prevalence (Hublin et al., 2010). Within their cohort of Finnish adults (n=20,142), Hublin et al., (2010) found that although there were incidences of CVD mortalities and hypertension, there was no significant associations between shift work and CVD prevalence. Similarly, while shift workers were found to have a greater prevalence of obesity and significantly higher SBP in a sample of glucose tolerant industrial workers (n=319), this was determined to be independently attributable to a higher body mass index (BMI) and unrelated to shift work (Di Lorenzo et al., 2003). Even studies that did observe increases in their shift working cohorts' BP suggest it is likely due to behavioural mechanisms (Ohlander et al., 2015), or the frequency of shifts greater than 12 hours in length (Choi et al., 2016). This theory is further supported by the increased prevalence of obesity found among shift workers (Antunes et al., 2010), with other authors suggesting that longer periods of employment in shift work directly correlates with increases in BMI (van Amelsvoort et al., 1999). In comparison, Virkkunen et al., (2007) found that within their sample of industrially employed middle-aged men (n=884) there was no significant difference in BP levels between day and shift working individuals. Another study assessed an 88.2% female sample of nurses, nursing technicians and assistants (n=493), and similarly found no significant difference between day and night workers' BP, or their prevalence of hypertension when using a univariate analysis (Sfreddo et al., 2010). Finally, Puttonen et al., (2009) found shift work to have a significant impact on the acceleration of atherosclerotic plaque formation, although no significant differences were found between the BP levels of the day and shift workers in their sample of young adults (n=1,543). Using ultrasound-guided screening, there was a two-fold increase in carotid plaque formation in male subjects, however they suggest the absence of a significant difference in shift workers' BP may be due to their relatively young aged sample (24 to 39 years) (Puttonen et al., 2009). Newer theories have suggested metabolic mechanisms underlying the accelerated plaque formation observed among shift workers (Haupt et al., 2008; Jankowiak et al., 2016), supported by evidence of increased circulating inflammatory markers and resistin levels (Sookoian et al., 2007; Burgueno et al., 2010; Kim et al., 2016b; Morris et al., 2016). In conclusion, while there remain opposing views with regards to the hypothesised effect shift work may have upon BP regulation, there is currently insufficient knowledge of this area and highlights the need for further research.

Chapter 2 Basis for Research

Although concerns have been raised over the deleterious effects both shift work and policing have upon an individual's health, there is limited and often contentious research in the scientific literature. Elucidated upon in Section 1.4, the potential impact shift work may have upon the cardiovascular system is disputed (Suwazono et al., 2008; Hublin et al., 2010; Sfreddo et al., 2010; Jermendy et al., 2012; Ohlander et al., 2015), and there is a glaring limitation due to the lack of female subjects within the cohorts assessed. Police officers provide an irreplaceable service through law enforcement for modern society, hence their occupational safety is of great importance. It is the inherently stressful nature of the profession, in combination with their diminished sleep quality and quantity, which is believed to be responsible for police officers' increased prevalence of cardiovascular risks (Brown & Trottier, 1995; Kales et al., 2009). Studies specifically on general duties police officers in Australia is also minimal, and as cross-cultural extrapolations are often unsuitable (Davidson & Veno, 1980), hence further research is essential to determine their occupational health and safety, both physically and mentally.

Australia's social and economic burdens with regards to cardiovascular disease (CVD), occupational injury and fatigue are substantial (Australian Safety & Compensation Council, 2009; Safe Work Australia, 2015; National Heart Foundation of Australia, 2016). CVD is an insidious threat to an individual’s health, remaining as the most expensive disease group in Australia at $7.5 billion (Begg et al., 2007), and greatly increasing the likelihood of suffering stroke or myocardial infarction (Nichols et al., 2016). Fatigue and work-related injuries in Australia were estimated to have cost $28 billion between 2012-2013 (Safe Work Australia, 2015), and unsurprisingly shift workers were found to have over double the injury rate of non-shift workers (Safe Work Australia, 2016). Finally, there is an immediate need for studies like the one proposed when police in Australia make up the most frequent workers compensation claims (Safe Work Australia, 2013), with female officers having almost twice as many claims as the second highest occupation.

While there have been suggestions as to the potential benefits of napping interventions and shift work designs (Knauth, 1993; Smith et al., 2007), additional research is needed to identify the compounding effect shift work may have upon the inherently hazardous occupation of policing. Should associations be found between shift work and changes in BP, stress or fatigue levels, it could lead to improved health and fatigue management, better shift work roster systems, while most importantly benefitting the collective work-based safety of the NSW Police Force, and subsequently, the greater community. By assessing a sample of general duties police officers of the NSW Police Force before and after their respective shift, this study will endeavour to identify the adverse stress, fatigue and cardiovascular effects of shift work. Furthermore, comparisons will also be made between police officers based on their sex, shift and occupational rank, hence leading to the objectives of the current study.

2.1 Research Questions

The research questions for this study are as follows:

1. Is there a difference in BP before and after shift work in police officers?

2. Are police officers' stress/coping and sleep/fatigue levels affected by shift work?

3. What are the associations between shift work and BP, stress/coping and sleep/fatigue?

4. Are there differences in BP, stress/coping and sleep/fatigue between police officers based on their sex, shift and occupational rank?

5. Are the associations between shift work and BP, stress/coping and sleep/fatigue influenced by sex, shift and occupational rank?

2.2 Hypotheses

1. There will be a significant change in police officers' BP after shift work.

2. There will be high levels of stress and fatigue among the shift working police officers.

3. There will be significant association in the police officers' BP, stress/coping and sleep/fatigue linked to shift work.

4. There will be significant differences between police officers' BP, stress/coping and sleep/fatigue based on their sex, shift and occupational rank.

5. There will be different significant associations between police officers' shift work and BP, stress/coping and sleep/fatigue based on their sex, shift and occupational rank.

2.3 Aims

The aims of this study are to assess the following in a sample of general duties police officers:

1. To compare pre and post-shift BP.

2. To assess stress/coping and sleep/fatigue levels.

3. To identify associations between shift work and BP, stress/coping and sleep/fatigue.

4. To investigate if differences exist between police officers' BP, stress/coping and sleep/fatigue based on their sex, shift and occupational rank.

5. To investigate if different associations exist between police officers' BP, stress/coping and sleep/fatigue based on their sex, shift and occupational rank.

Chapter 3 Methodology

The research methodology presented below was developed with the intent of addressing the hypotheses and aims presented in Chapter 2. The participant population, protocols and measures of this cross-sectional study are discussed at length.

3.1 Participant Recruitment

A total of 225 police officers were recruited from the New South Wales (NSW) Police Force for the present study. Data from a further 100 general duties police officers' data was added to this sample from a similar experimental protocol conducted by this researcher and the Neuroscience Research Unit of the University of Technology Sydney (UTS) (Elliott & Lal, 2016). The study was endorsed by both the NSW Police Force and Police Association of NSW, which allowed contact to be made for recruitment purposes with either superintendents or liaison officers of ten different Local Area Commands (LAC). These LAC's included Campsie, Eastwood, Leichhardt, Macquarie Fields, Marrickville, Newtown, Northern Beaches, North Shore, Parramatta and Quakers Hill (whose locations are visualised in Figure 3.1). Officers who were on duty during the period of assessment were invited to be involved in the study.

Figure 3.1 – Participant recruitment map

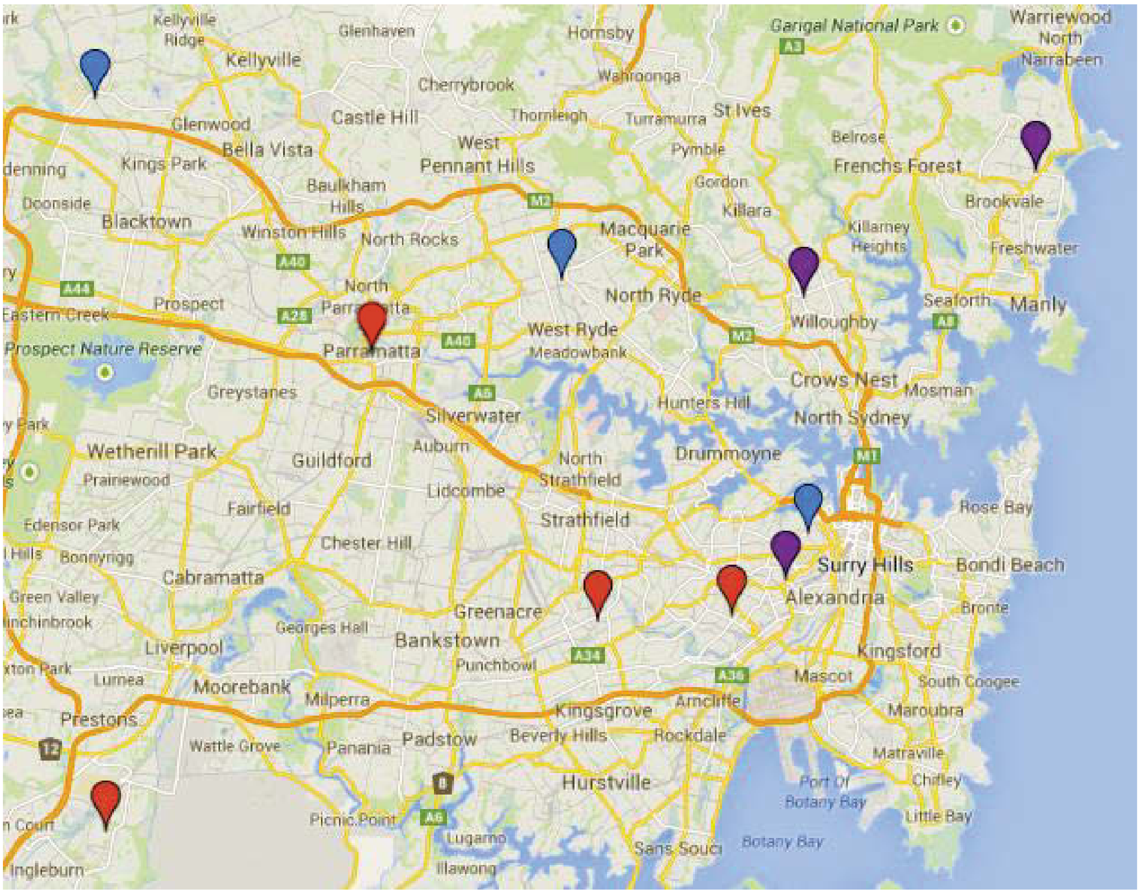

Figure 3.1 illustrates the ten LAC's of the NSW Police Force where participants were recruited from. The pins are located at each of the sites, including Campsie, Eastwood, Leichhardt, Macquarie Fields, Marrickville, Newtown, Northern Beaches, North Shore, Parramatta and Quakers Hill. Blue signifies that the LAC's were visited only during the associated Honours project (Elliott & Lal, 2016), while red sites were only attended during the PhD and participants at purple pins were tested during both studies. The map utilised is courtesy of Google Maps (2017).

3.2 Ethics Approval & Informed Consent

This study had the Human Research Ethics Committee (HREC) approval (HREC2006-176A) of UTS. Superintendents of each LAC were contacted prior to assessment and were informed in detail regarding the test protocols and selection criteria. The study was also explained in depth to potential volunteers and they were also invited to ask questions, while assuring that any individual details and results would remain confidential and anonymous. A consent form was supplied to each participant, which had to be read and signed by both the researcher and subject after which each retained a signed copy (see Appendix 8.1).

3.3 Selection Criteria

Police officers who wished to participate in the project were subjected to strict selection criteria. An introductory questionnaire (see Appendix 8.2) was issued to determine suitability based upon the UTS HREC guidelines and selected questions drawn from part one of the Lifestyle Appraisal Questionnaire (LAQ) (Craig et al., 1996). Inclusion criteria included employment as a general duties police officer, aged between 18 and 69 years, who regularly worked at least four 12 hour shifts weekly. Participants were also required to be free of any ongoing health issue or disease as determined by question 18 of the LAQ: "Do you, at present, suffer from any chronic illness such as cancer, diabetes, asthma, heart disease, etc.?”. A positive response to this question resulted in the exclusion of the subject from the study; this impeded the effect a known disease state could have upon collected data and was in accordance with the UTS HREC requirements. Finally, police officers were excluded if they consumed 16 or more standard drinks per day, smoked 10 or more cigarettes or took any illicit substances/daily medications (determined by questions 2, 7 and 8 of the LAQ respectively). This was to diminish the potential influence these substances could have upon the physiological measurements (Chobanian et al., 2003; Myers, 2004; Erblich et al., 2011; Mesas et al., 2011), thereby improving the reliability of the data obtained in this study.

Upon completion of the administered introductory questionnaire, left arm brachial artery blood pressure (BP) was recorded three times and an average BP value derived (refer to Section 3.4.1 for further details). Volunteers were excluded if they had average systolic blood pressure (SBP) and/or diastolic blood pressure (DBP) greater than or equal to 160mmHg/100mmHg respectively. This was compliant with the ethics requirements for this study, while also being in accordance with the National Heart Foundation of Australia, (2016) which identifies BP of greater than 160/100mmHg to be criteria for moderate hypertension and increases the risk of a cardiovascular event. However, if BP was greater than 140/90mmHg and less than 160/100mmHg the police officer was included in the study and advised to discuss their raised BP levels with a general practitioner, which conformed to the UTS HREC guidelines.

Of the 325 police officers recruited for the study, 70 were excluded for the following reasons (summarised in Table 3.1). Forty seven officers did not regularly work 12 hour shifts or return post-shift with their questionnaire battery. Seven were excluded due to high BP (detailed above), having a chronic illness or currently being pregnant, while five admitted to smoking >10 cigarettes a day. Another seven were excluded due to daily medication usage (including antidepressants, oral contraceptives and BP lowering drugs), and only four subjects were found to have been assessed in both the previous and current study, in which case only their new data was included. This brought the total sample population for the study to 255, with the breakdown of each subgroup based on their sex, shift or occupational rank visualised in Figure 3.2 a, b and c.

Table 3.1 – Breakdown of reasons for exclusion of police officers

PhD Total Recruited	325
Not working 12 hours, did not return post-shift and/or questionnaire	47
BP ≥160/100mmHg and/or chronic illness/pregnancy	7
Smoked >10 cigarettes per day	5
Daily Medication Usage	7
Duplicate	4
PhD study sample size (n)	255

Table 3.1 summarises the reasons for participant exclusion based on the UTS HREC guidelines and select questions of the LAQ (Craig et al., 1996). The total sample for the present study was 255 general duties police officers.

Figure 3.2 – Sample distribution of each sub-group

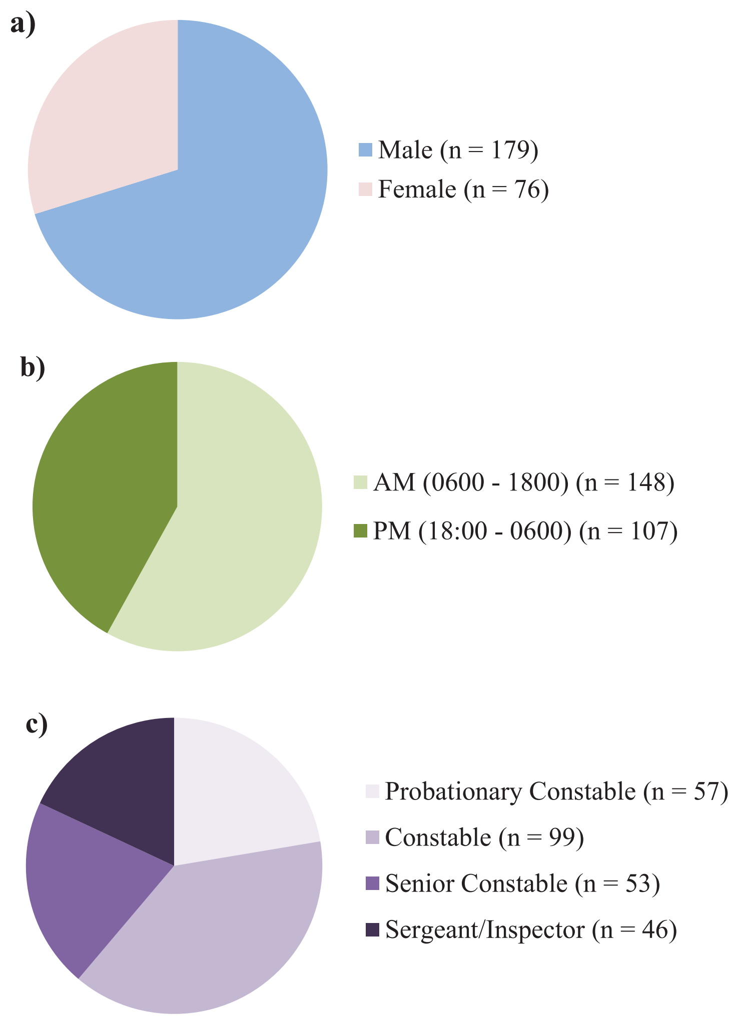

Figure 3.2 (a, b and c) show the sample distribution based on the established comparison groups within the total sample of 255 general duties police officers. These involved 179 males vs. 76 females (Figure 3.2a), and 148 working an AM shift (0600 – 1800) while 107 were working a PM shift (1800 – 0600) (Figure 3.2b) at the time of assessment. Further, 57 were probationary constables, 99 were constables, 53 were senior constables and 46 were either sergeants or inspectors (who were grouped together) (Figure 3.2c).

3.4 Research Protocol

This study's experimental protocol was performed on site at ten LAC's of the NSW Police Force. Subjects were assessed in private interview rooms so as to minimise potential auditory or visual interference and maintain confidentiality. The ability to assess police officers within their own occupational environment was beneficial as it reduced the likelihood of potential 'white coat hypertension' associated with clinical laboratory settings (National Heart Foundation of Australia, 2016). Further, volunteers were asked to abstain from caffeine and nicotine for 4 hours, and from alcohol for 12 hours, prior to assessment to avoid the impact these substances are known to have and maintain data reliability (Chobanian et al., 2003; Myers, 2004; Erblich et al., 2011; Mesas et al., 2011).

3.4.1 Blood Pressure Measurement

After completion of the introductory questionnaire, BP was measured from each volunteer's left arm, before and after their 12 hour shift, using an automated BP monitor (Livingstone, OMRON IA1B, Japan), as illustrated in Figure 3.3. Resting (baseline) BP was obtained by having subjects sit quietly for five minutes prior to assessment. For both pre and post-shift sessions, BP was recorded three times with one to two minute intervals to ensure the most accurate measurement of the officers' BP (Eguchi et al., 2009), while an average value of the three BP readings was also determined due to the variability of BP (Burstyn et al., 1981). As was detailed in Section 3.3, participants who failed the initial BP screening (>160/100mmHg) were excluded and advised to consult with their general practitioner, as well as being offered to be escorted to the nearest medical centre (as per HREC guidelines and as outlined in the consent form in Appendix 8.1). After recording the participants' BP measurements, and determining their suitability based on the inclusion criteria, subjects were supplied with a copy of the questionnaire battery (Section 3.4.2) and invited to continue their regular twelve hour shift.

Figure 3.3 – Automated BP monitor placement

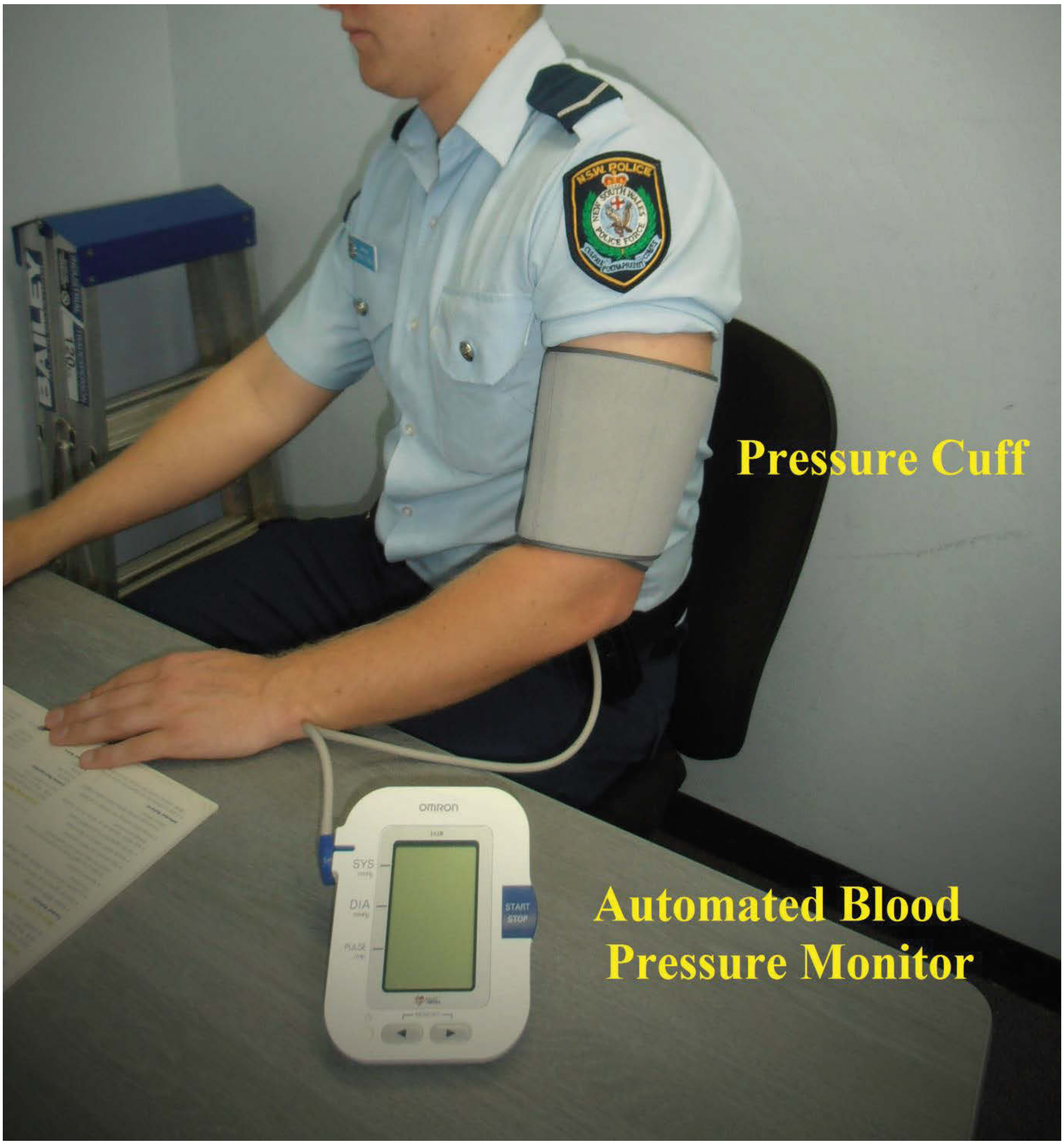

Figure 3.3 shows the proper placement of an automated blood pressure (BP) monitor. The pressure cuff is placed over the upper arm, with no clothing obstructing the occlusion of the brachial artery. This device is able to accurately measure BP. Permission granted by participant to reproduce the image.

3.4.2 Questionnaire Battery

The questionnaire battery utilised included a selection of proven and reliable tools used to assess the following variables; lifestyle risk factors, perceptions of stress, coping style prevalence, sleep quality, sleepiness risk, fatigue severity and total impact of fatigue. These included the LAQ, Ways of Coping Questionnaire Revised (WCQR), Pittsburgh Sleep Quality Index (PSQI), Epworth Sleepiness Scale (ESS), Fatigue Severity Scale (FSS), Checklist of Individual Strength (CIS20) and Survey of Shiftworkers (SOS) (detailed in Sections 3.4.2.1 – 3.4.2.7 respectively).

3.4.2.1 Lifestyle Appraisal Questionnaire (LAQ)

The participants' lifestyle risk factors and perceptions of stress were assessed using the LAQ, a reliable and validated questionnaire which provides clinically relevant demographic and subject stress-oriented information (Craig et al., 1996). The first section (Part 1) required officers to answer 22 questions that have predetermined values for each response, which may then be summed to provide a total score (with a maximum of 73). Those with greater scores are suggested to be at a higher risk of developing a chronic illness based on the LAQ's identified lifestyle risk factors. While body mass index (BMI) is used as part of the LAQ Part 1's scoring, this study also assessed officers' Waist-Hip Ratio (WHR), as it appears to be more strongly associated with cardiovascular and metabolic risk factors than BMI (de Koning et al., 2007). Following the World Health Organization's guidelines, the subject's WHR was measured using a stretch-resistant tape around the smallest portion of the waist and the widest circumference of the hips after normal exhalation (World Health Organization, 2011). Two measurements are taken each time, and if the values are within 1cm of each other they are recorded and averaged. The participant's WHR is determined by dividing their waist circumference by the hip circumference, with abdominal obesity defined as above 0.90 for males and 0.85 for females (World Health Organization, 2011).

Part 2 of the LAQ evaluates the subject's perception of stress based on their response to 27 Likert-type scale questions which involve various sources of stress. Again, a total score may be determined (with a maximum of 75) indicating the highest perceived level of stress, however there are also normative threshold scores offered by the authors (summarised in Table 3.2) based on age and sex brackets (Craig et al., 1996).

Table 3.2 – Normative data for Part 2 of the LAQ

Gender	Perception of Stress (Part 2 LAQ)					
	Group 1			Group 2		
	Age	n	Mean (SD)	Age	n	Mean (SD)
Males	< 30	131	19.4 (9.7)	< 30	10	24.6 (5.7)
	30 - 50	86	18.8 (9.3)	30 - 50	50	24.1 (12.9)
	> 50	63	17.1 (10.7)	> 50	10	18.9 (11.1)
Females	< 30	139	20.9 (9.7)	< 30	16	22.8 (11.1)
	30 - 50	126	21.3 (10.9)	30 - 50	48	23.4 (11.1)
	> 50	55	18.0 (10.7)	> 50	9	19.2 (7.11)

Table 3.2 shows the normative scores for Part 2 of the LAQ. Group 1 consisted of randomly selected members of a local community, while Group 2 was a sample of randomly selected university staff. Both groups provide adult norms, with scores distributed by age and gender. Adapted from (Craig et al., 1996), page 338.

Key: LAQ = Lifestyle Appraisal Questionnaire, SD = Standard deviation, n=Sample size

3.4.2.2 Ways of Coping Questionnaire Revised (WCQR)

The police officers' behavioural and cognitive coping style prevalence was assessed using the WCQR (Folkman et al., 1986). Based on the original Ways of Coping Questionnaire (Folkman & Lazarus, 1980), it required subjects to recall the most stressful event in the past week and consider the frequency of 66 different responses (in a Likert-style), ranging from 'not used' to 'used a great deal'. Their responses form eight subscales which reflect various coping mechanisms; Confrontive Coping, Distancing, Self-Controlling, Seeking Social Support, Accepting Responsibility, Escape-Avoidance, Planful Problem-Solving and Positive Reappraisal. With strong alpha reliability scores ranging from 0.66 – 0.79, the WCQR has been used in a great deal of police officer studies to assess their coping styles (Evans et al., 1993; Patterson, 2000).

3.4.2.3 Pittsburgh Sleep Quality Index (PSQI)

Developed by Buysse et al., (1989), the PSQI assesses overall sleep quality over the past month. After applying a simple and brief scoring system of the 19 items, seven different domain scores can be calculated which have been shown to influence overall sleep quality; subjective sleep quality (Component 1), sleep onset latency (Component 2), sleep duration (Component 3), habitual sleep efficiency (Component 4), incidence of sleep disturbances (Component 5), use of sleep medications (Component 6) and daytime dysfunction (Component 7). These seven components conform to a Likert scale of 0 - 3 (with 3 reflecting the negative extreme), which may then be summed to provide a global PSQI score (which has a maximum of 21). A global score of greater than 5 indicates significant sleep disturbances and has been found to have diagnostic sensitivity of 89.6% and specificity of 86.5% in distinguishing between "good" and "poor" sleepers (Buysse et al., 1989), while a Cronbach's alpha of 0.80 reflects its high internal consistency (Carpenter & Andrykowski, 1998). Further, the PSQI has been shown to measure subjective sleep quality of patients with Chronic Fatigue Syndrome (CFS), where established objective parameters failed to distinguish them from normal controls (Neu et al., 2007).

3.4.2.4 Epworth Sleepiness Scale (ESS)

The ESS is a simple and reliable questionnaire used to measure an individual's level of daytime sleepiness (Johns, 1991). It involves eight circumstances associated with subjective sleepiness that are scored using a Likert scale from 0 - 3 (0 = never doze, 3 = high chance of dozing). The scores are summed to provide a total which has maximum of 24 indicating the highest sleep propensity due to the individual's daytime sleepiness risk. The ESS has a Cronbach's alpha ranging from 0.79 - 0.88 (Johns, 1992; Heaton & Anderson, 2007), and test-retest reliability of 0.82, which shows the questionnaire's strong internal consistency. Finally, it has repeatedly been shown to identify significant correlations between a subject's daytime sleepiness and their pre-existing sleep pathologies (Shahid et al., 2010).

3.4.2.5 Fatigue Severity Scale (FSS)

With a similar structure to the ESS, the FSS measures an individual’s severity of fatigue over the past week (Krupp et al., 1989). Nine items are presented in the Likert style, with respondents answering from 1 (for no fatigue) to 7 (for severe fatigue), where a total score can then be calculated (with a maximum of 63). Higher scores are indicative of greater fatigue impact on behaviour and general functioning, with scores greater than or equal to 36 considered to be above the normal threshold (Krupp et al., 1989). A very widely used tool to measure fatigue, the FSS has been found to have high test-retest reliability (0.84) (Shahid et al., 2010), be able to distinguish between different disease states (Hossain et al., 2003) and a Cronbach’s alpha ranging from 0.81 – 0.88 (Loge et al., 1998).

3.4.2.6 Checklist of Individual Strength (CIS20)

Although originally developed for clinical studies (Vercoulen et al., 1994), the CIS20 has been found to be an excellent tool for the measurement of various fatigue factors. 24 statements involving different perceptions of fatigue are presented, with respondents registering their subjective accuracy over the past fortnight using a 7-point Likert scale (with the value inverting based on the specific question). Their responses are used to calculate four subscales (subjective experience, reduced concentration, reduced motivation and physical activity), however a total fatigue score can also be determined (Bültmann et al., 2000), with values greater than 35 indicating severe fatigue impact (Worm-Smeitink et al., 2017). Finally, the CIS20 has been validated for patients with CFS (Shahid et al., 2010), can differentiate between different disease states like the FSS and has Cronbach's alpha scores ranging from 0.84 – 0.95 (Bültmann et al., 2000) and a test-retest reliability of 0.74 – 0.86 (Worm-Smeitink et al., 2017).

3.4.2.7 Survey of Shiftworkers (SOS)

Seeking to improve response rates and overall compliance, the SOS is a shortened version of the Standard Shiftwork Index developed by Barton et al., (1995). While certain scales have been reduced (CFS, morningness, flexibility, etc.) and coping items omitted, the SOS remains a formidable amalgamation of questions seeking to directly address factors pertaining to the general impact of different shift work systems (Folkard et al., 1995; Kaliterna & Prizmić, 1998; Tucker et al., 2000). While it did offer novel variables, like Total Travel Work (TTW) time, the SOS was mainly used as a repeated measure to ensure accuracy and honesty in participants' responses, as it assessed many of the same components as the other questionnaires utilised in this battery.

3.4.3 Experimental Protocol Summary

The subjects returned to the interview room after their 12 hour shift and the researcher collected their completed questionnaires. An additional three BP measurements were taken (according to the procedure explained in Section 3.4.1). Figure 3.4 is a flowchart which summarises this study's entire experimental protocol, including sequential steps in the event of an emergency.

Figure 3.4 – Experimental protocol summary flowchart

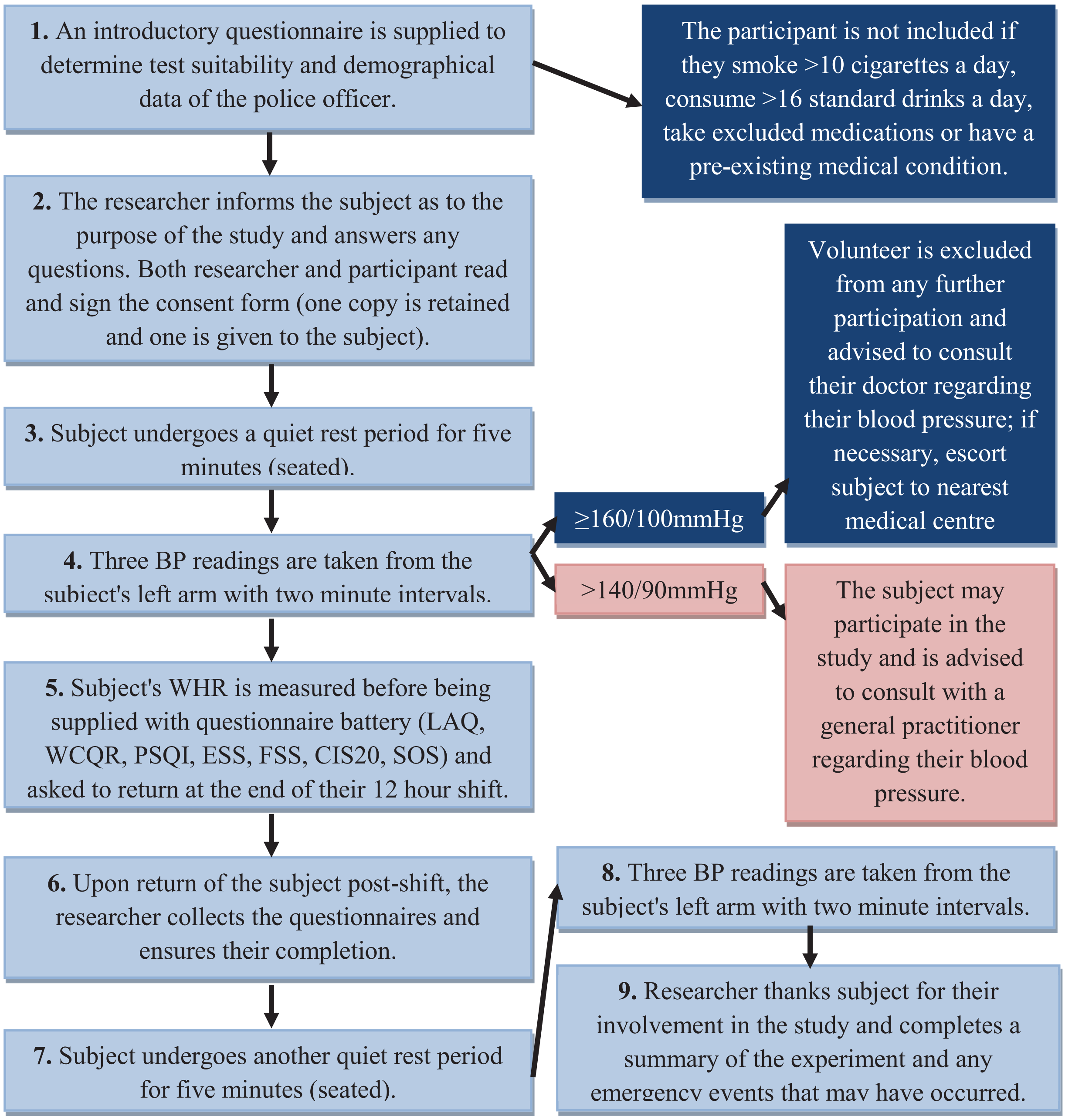

Figure 3.4 summarises the experiment protocol of this study. The selection criteria of steps 1 and 4 were approved by the Human Research Ethics Committee of the University of Technology, Sydney.

Key: BP = Blood Pressure, CIS20 = Checklist of Individual Strength, ESS = Epworth Sleepiness Scale, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQI = Pittsburgh Sleep Quality Index, SOS = Survey of Shiftworkers, WCQR = Ways of Coping Questionnaire Revised, WHR = Waist-Hip Ratio; mmHg = Millimetres Mercury

3.5 Data Processing

The data that was analysed in the current study included general duties police officers' BP measurements taken before and after shift work, lifestyle risk factors (LAQ Part 1), perception of stress (LAQ Part 2), coping style prevalence (WCQR), overall sleep quality (PSQI), daytime sleepiness (ESS), fatigue severity (FSS) and total impact (CIS20), as well as participants' WHR and TTW (SOS).

3.5.1 Blood Pressure & WHR Data

BP values were obtained before and after the police officers' 12 hour shift. Detailed in Section 3.4.1, three readings were recorded to derive an average value for each measurement of SBP and DBP. Further, subjects' WHR was determined following World Health Organization (2011) guidelines.

3.5.2 Questionnaire Data

A questionnaire battery was completed by subjects during the course of their regular 12 hour shift and collected by the researcher at post-shift assessment. Reponses to the questionnaires were tabulated, after which necessary scoring systems were undertaken. These included determination of the total scores for the LAQ, PSQI, ESS, FSS and CIS20. Finally, TTW was calculated by adding the time required for officers to travel to and from work over the course of a week, based on their responses in the SOS.

3.6 Statistical Analysis

Statistical analyses were executed using the software programs Statistica (Version 8, 1999, StatSoft, USA) and SPSS (Version 22, 2013, IBM Corp, USA). Data analysis was used to identify differences in BP after shift work, as well as associations with other variables drawn from the questionnaire battery for the total sample (N=255), as well as the established subgroups (summarised in Figure 3.2). Comparisons were also made using statistical analyses between male and female police officers (n=179 and 76 respectively), day and night shift officers (n=148 and 107 respectively), and officers based on their occupational rank; probationary constables (PC) (n=57), constables (C) (n=99), senior constables (SC) (n=53) and sergeants (Sgt) (n=46). Statistical significance was determined at a p-value of <0.05 (Heiman, 2010).

3.6.1 Power Analysis

As statistical power increases with larger sample sizes (Thomas & Krebs, 1997), power analysis was performed based on the desired moderate effect (p=0.4), minimum sample size was determined to be n=81 with 80% power ($\alpha=0.05$). Thus the current study's total sample size of 255 NSW general duties police officers provided sufficient sample power for the necessary statistical analyses performed (Cohen, 1988).

3.6.2 t-tests (Dependant & Independent)

Dependant sample t-tests were utilised to identify significant differences between pre and post-shift SBP and DBP measurements for all samples of police officers. Independent sample t-tests were also used to identify significant differences between the BP values and questionnaire scores of police officers based on their sex and shift (day vs night) at time of assessment (Everitt & Palmer, 2011). Dependant sample t-tests may be used to analyse the size and significance of differences between means of normally-distributed paired samples, while independent sample t-tests are used when comparing the means between two separate and independent data sets (Heiman, 2010).

3.6.3 Analysis of Variance (ANOVA)

To identify significant differences in the data between the police officers based on their occupational rank, analysis of variance (ANOVA) was performed. An extension of the t-test (Section 3.6.2), ANOVA allows the comparison between the means of three or more independent samples and provides a p-value (Heiman, 2010). If significant, Tukey post-hoc tests (refer to Section 3.6.5) were performed to determine where the differences lay between a comparison of the means for the different occupational ranks of the police officers assessed.

3.6.4 Multivariate Analysis of Covariance (MANCOVA)

Multivariate analysis of covariance (MANCOVA) was also used to compare BP values between police officers based on their occupational rank. Similar to ANOVA, MANCOVA allows the comparison of three or more independent samples while also controlling for specified covariates (Everitt & Palmer, 2011). Bivariate Pearson's correlations (detailed in Section 3.6.6) were performed to determine potential covariates (including age, sex, smoking status, WHR, perception of stress and lifestyle risk factors). Where covariates were found to be significant, a MANCOVA was executed to account for those identified variables when analysing BP data. For this study, the significant covariates identified (and utilised in both MANCOVA and partial Pearson's correlations with police officers' BP) were age, sex, WHR and lifestyle risk factors (LAQ Part 1). Finally, if the MANCOVA was found to be significant, Tukey post-hoc tests (refer to Section 3.6.5) were performed to determine where the differences lay between a comparison of the means for the different occupational ranks of the police officers assessed.

3.6.5 Tukey's Honestly Significant Difference (HSD) Post-hoc Analysis

Based on the significant associations determined by the ANOVA/MANCOVA p-values, Tukey post-hoc honestly significant difference (HSD) analyses (Heiman, 2010) were performed. This allowed the elucidation of exactly where differences lay between the comparisons of police officers based on their occupational rank.

3.6.6 Pearson’s correlation (Bivariate & Partial)

Pearson’s correlations were performed to evaluate the relationships between BP and perception of stress (LAQ Part 2), coping style prevalence (WCQR), overall sleep quality (PSQI), sleepiness risk (ESS), fatigue severity (FSS) and total impact (CIS20), as well as WHR and TTW (SOS). Bivariate Pearson’s correlations were performed to evaluate the non-cardiac associations (Chapters 5 and 6); they assess the strength of a linear relationship between two variables, which produces a 'r' (rho) value ranging from -1 to 1 (Everitt & Palmer, 2011). The strength of the positive or negative relationship is indicated by the r-value, with an r-value of -1 showing that as one variable increases the other decreases by the same amount; this is known as an inverse relationship. Whereas when an r-value equals 1 it indicates that as one variable increases the other also increases by the same amount, which is known as a direct relationship (Heiman, 2010). By comparison, partial Pearson’s correlations were performed between BP and all other variables after accounting for significant covariates (detailed in Section 3.6.4), thereby controlling for the influence of these identified variables.

3.6.7 Multiple Regression Analysis

Based on the correlations performed, if three or more variables were found to be significantly associated ($p<0.05$) to the dependent variable, subsequent regression analyses were performed to examine the nature of the linear relationship between the identified variables (Everitt & Palmer, 2011). Multiple linear regression analyses were used in the present study to identify the most significant predictors of non-cardiac variables, as these were the only dependent variables with three or more significant predictors identified by bivariate Pearson's correlations (detailed in Section 3.6.6). By comparison, hierarchical multiple regression analyses were performed for BP values where three or more significant variables were correlated, while also accounting for the identified covariates in a combined model (detailed in Section 3.6.4).

Chapter 4 Blood Pressure and Shift Work

4.1 Results: Blood Pressure and Shift Work

A total of 225 police officers were recruited for the present study which, after selection criteria was applied (see Section 3.3), provided an inclusive sample of 159 (subjects' reasons for exclusion detailed in Section 3.3, Table 3.1). These participants were added to an existing data base of 100 police officers, obtained using a similar experimental protocol conducted by this researcher and the Neuroscience Research Unit of the University of Technology Sydney (UTS) (Elliott & Lal, 2016).

This chapter reports the total sample's (N=255) descriptive statistics, before presenting partial correlations and subsequent hierarchical multiple regressions (detailed in Section 3.6) between cardiac measures and other variables. Finally, further descriptive statistics, associations and comparisons are provided for distinct sample populations; males (n=179) vs. females (n=76), day (n=148) vs. night shift (n=107) and rank (probationary constable, constable, senior constable and sergeant; n=57, 99, 53 and 46 respectively).

4.1.1 Results: Blood Pressure and Shift Work (total sample)

This section presents the results in the context of the total sample (N=255). Their demographics, blood pressure (BP), and related correlation and regression analyses follow.

4.1.1.1 Demographics (total sample)

Mean (± SD) demographics are provided for the total sample (N=255) (Table 4.1). Officers assessed were aged between 20 – 58 years old, with a mean age of 31.31 ± 8.59 years. Although all were actively serving general duties police officers, their individual years of service in the NSW Police Force ranged from ≤1 to 37 years, with an average of 6.59 ± 7.71 years in active service. The total sample's mean WHR was 0.85 ± 0.07, while total travel work time (TTW) varied greatly, with 315.39 ± 233.96 hours being the mean required to attend work and return home over the regular four weekly shifts. Finally, their mean lifestyle risk factor score (LAQ Part 1) of 13.00 ± 5.95 was below the normative threshold value (18.3 ± 7.9) for their age bracket according to Craig and colleagues (1996).

Table 4.1 – Mean demographic values for the total sample (N=255)

	Demographics	Value (Mean ± SD)
Total sample (N=255)	Years of Age	31.31 ± 8.59
	Years of Service	6.59 ± 7.71
	WHR	0.85 ± 0.07
	TTW	315.39 ± 233.96
	Lifestyle Risk Factors (LAQ Part 1)	13.00 ± 5.95

Table 4.1 shows mean demographic scores for the total sample of general duties police officers (N=255). Total travel work time (TTW) was calculated by averaging the hours required to travel to and from work across the course of the average week. The maximum score for the LAQ Part 1 (lifestyle risk factors) is 70, with greater scores indicating an increased likelihood of developing a chronic illness (Craig et al., 1996).

Key: LAQ = Lifestyle Appraisal Questionnaire, TTW = Total Travel Work Time, WHR = Waist-Hip Ratio; n=Sample size, SD = Standard Deviation, ± = Plus and minus

4.1.1.2 Blood Pressure (total sample)

Mean (± SD) BP values are presented for the total sample (N=255) (Table 4.2). BP was measured before and after officers' regular twelve hour shift, with a paired sample t-test used to determine whether BP was significantly different across the shift. There was a significant increase in subjects' Systolic Blood Pressure (SBP) (p=0.02), but not for their Diastolic Blood Pressure (DBP).

Table 4.2 – Mean cardiac values for the total sample (N=255)

Total sample (N=255)	Variable	Pre-Shift	Post-Shift	BP Reactivity	p
	SBP ± SD (mmHg)	127.71 ± 12.46	128.90 ± 12.29	1.19 ± 8.13	**0.02**
	DBP ± SD (mmHg)	76.69 ± 8.76	76.66 ± 9.12	-0.28 ± 6.10	-

Table 4.2 shows mean cardiac values for the total sample of general duties police officers (N=255). BP was taken before and after the subjects' regular shift, with reactivity calculated by deducting the pre-shift from the post-shift result. Dependant sample t-tests were performed and officers' SBP was found to be significantly greater after shift.

Key: BP = Blood Pressure, DBP = Diastolic Blood Pressure, SBP = Systolic Blood Pressure; mmHg = Millimetres of mercury, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), SD = Standard Deviation, ± = Plus and minus, - = Not significant

4.1.1.3 Blood Pressure Associations & Regression Analyses (total sample)

Pearson's correlations were applied to identify which covariates were significantly related to the dependant variable, BP. Age, sex, Waist-Hip Ratio (WHR) and lifestyle risk factors, as determined by the Lifestyle Appraisal Questionnaire Part 1 (LAQ), were found to potentially influence subjects' BP ($p<0.001$) (Section 3.6.4). Partial correlations were then performed to identify the relationship between subjects' BP and the independent variables. Where three or more independent variables were found to be significantly correlated with the dependant variable of BP, consequent hierarchical multiple regressions were performed to identify the significant predictors.

SBP was found to have a number of significant relationships with independent variables, after accounting for the effects of age, sex, WHR and lifestyle risk factors (LAQ Part 1) (Table 4.3). Pre-shift SBP showed negative relationships with perception of stress (LAQ Part 2) ($r=-0.18$, $p=0.004$), frequency of sleep disturbances ($r=-0.13$, $p=0.042$) and daytime dysfunction ($r=-0.19$, $p=0.003$), as determined by the Pittsburgh Sleep Quality Index (PSQI) Components 5 and 7 respectively (Buysse et al., 1989). Further negative relationships were also identified with fatigue severity (FSS) ($r=-0.22$, $p=0.007$), Distancing ($r=-0.16$, $p=0.045$) and Escape-Avoidance ($r=-0.17$, $p=0.036$) coping style prevalence, as well as subjective fatigue ($r=-0.19$, $p=0.017$), reduced concentration ($r=-0.21$, $p=0.010$) and total fatigue ($r=-0.21$, $p=0.008$), as determined by the Ways of Coping Questionnaire Revised (WCQR) (Folkman et al., 1986) and Checklist of Individual Strength (CIS20) (Vercoulen et al., 1994) respectively. A subsequent hierarchical multiple regression (Table 4.4) was performed using the significant correlations identified and was found to be overall significant for pre-shift SBP ($F(13,144) = 6.51$, $p<0.001$). Together the independent variables explain 37% of the variance in pre-shift SBP, with the covariates of sex ($p<0.001$) and lifestyle risk factors ($p=0.008$) being the significant predictors.

Post-shift SBP was found to share a number of similar negative relationships with pre-shift SBP, including perception of stress ($r=-0.17$, $p=0.007$), frequency of sleep disturbances ($r=-0.17$, $p=0.006$), daytime dysfunction ($r=-0.23$, $p<0.001$), fatigue severity (FSS) ($r=-0.27$, $p=0.001$), subjective fatigue ($r=-0.22$, $p=0.007$), reduced concentration ($r=-0.17$, $p=0.038$) and total fatigue ($r=-0.20$, $p=0.014$). However, a significant inverse relationship was also found between post-shift SBP and sleep medication usage ($r=-0.15$, p=0.016) (PSQIC6) and the global score of the PSQI (r=-0.19, p=0.002). A subsequent hierarchical multiple regression (Table 4.5) was performed using the significant correlations identified and was found to be overall significant for post-shift SBP ($F(13,144) = 5.28$, $p<0.001$) . Together the independent variables explain 32% of the variance in post-shift SBP, with the covariates of sex ($p<0.001$) and lifestyle risk factors (p=0.001) being the significant predictors.

Finally, SBP reactivity was found to be negatively correlated with sleep medication usage (r=-0.14, p=0.030) and positively associated with prevalence of Confrontive Coping style prevalence (r=0.20, p=0.012). No regressions were performed for SBP reactivity as there was less than three significant independent variables correlated.

Table 4.3 – Significant partial correlations between independent variables and SBP for the total sample (N=255)

	Independent Variables	Pre-Shift SBP		Post-Shift SBP		SBP Reactivity	
		r	*p*	*r*	*p*	*r*	*p*
Total sample (N=255)	Perception of Stress (LAQ Part 2)	-0.18	**0.004**	-0.17	**0.007**	-	-
	Sleep Disturbances (PSQIC5)	-0.13	**0.042**	-0.17	**0.006**	-	-
	Sleep Medication Usage (PSQIC6)	-	-	-0.15	**0.016**	-0.14	**0.030**
	Daytime Dysfunction (PSQIC7)	-0.19	**0.003**	-0.23	**<0.001**	-	-
	PSQI Global	-	-	-0.19	**0.002**	-	-
	Fatigue Severity (FSS)	-0.22	**0.007**	-0.27	**0.001**	-	-
	Confrontive Coping (WCQR1)	-	-	-	-	0.20	**0.012**
	Distancing (WCQR2)	-0.16	**0.045**	-	-	-	-
	Escape-Avoidance (WCQR6)	-0.17	**0.036**	-	-	-	-
	Subjective Fatigue (CIS20-1)	-0.19	**0.017**	-0.22	**0.007**	-	-
	Reduced Concentration (CIS20-2)	-0.21	**0.010**	-0.17	**0.038**	-	-
	Total Fatigue (CIS20-Total)	-0.21	**0.008**	-0.20	**0.014**	-	-

Table 4.3 shows significant results from partial Pearson's correlations between SBP and other independent variables for the total sample (N=255), accounting for the effects of age, sex, WHR and lifestyle risk factors.

Key: CIS20 = Checklist of Individual Strength, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, SBP = Systolic Blood Pressure, WCQR = Ways of Coping Questionnaire Revised; p = Level of statistical significance (p=<0.05 (in bold)), - = Not significant

Table 4.4 – Hierarchical multiple regression between pre-shift SBP and significantly correlated variables in the total sample (N=255)

Total Sample (N=255)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Pre-Shift SBP	0.61	0.37	0.31	10.32	**<0.001**
	B	Std. Error	Beta	T	p
(Constant)	153.59	15.18		10.12	**<0.001**
Age	-0.06	0.12	-0.04	-0.52	0.60
Sex	-13.60	2.24	-0.50	-6.08	**<0.001**
WHR	2.07	15.47	0.01	0.13	0.89
Lifestyle Risk Factors (LAQ Part 1)	0.47	0.17	0.22	2.71	**0.008**
Perception of Stress (LAQ Part 2)	0.00	0.14	0.00	0.03	0.98
Sleep Disturbances (PSQIC5)	0.00	1.92	0.00	0.00	0.99
Daytime Dysfunction (PSQIC7)	-1.02	1.35	-0.07	-0.76	0.45
Fatigue Severity (FSS)	-0.10	0.11	-0.09	-0.93	0.36
Distancing (WCQR2)	-0.40	0.32	-0.10	-1.24	0.22
Escape-Avoidance (WCQR6)	-0.08	0.25	-0.03	-0.33	0.74
Subjective Fatigue (CIS20-1)	0.02	0.27	0.02	0.08	0.94
Reduced Concentration (CIS20-2)	-0.12	0.30	-0.06	-0.40	0.69
Total Fatigue (CIS20-Total)	-0.04	0.17	-0.06	-0.25	0.81

Table 4.4 shows hierarchical multiple regression analysis between pre-shift SBP and significant variables as determined by partial correlations; perceptions of stress (LAQ Part 2), frequency of sleep disturbances and daytime dysfunction (PSQI Components 5 and 7 respectively), fatigue severity (FSS), prevalence of Distancing and Escape-Avoidance coping mechanisms (WCQR 2 and 6 respectively), as well as subjective fatigue (CIS20-1), reduced concentration (CIS20-2) and total fatigue (CIS20-Total). The model also accounts for the covariates of age, sex, WHR and lifestyle risk factors for the total sample (N=255).

Key: CIS20 = Checklist of Individual Strength, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, SBP = Systolic Blood Pressure, WCQR = Ways of Coping Questionnaire Revised, WHR = Waist-Hip Ratio; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Table 4.5 – Hierarchical multiple regression between post-shift SBP and significantly correlated variables in the total sample (N=255)

Total Sample (N=255)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Post-Shift SBP	0.57	0.32	0.26	10.56	**<0.001**
	B	**Std. Error**	**Beta**	**t**	**p**
(Constant)	158.94	14.87		10.69	**<0.001**
Age	0.04	0.12	0.03	0.33	0.74
Sex	-11.45	2.27	-0.43	-5.04	**<0.001**
WHR	-17.86	15.81	-0.11	-1.13	0.26
Lifestyle Risk Factors (LAQ Part 1)	0.64	0.18	0.31	3.55	**0.001**
Perception of Stress (LAQ Part 2)	-0.02	0.14	-0.02	-0.14	0.89
Sleep Disturbances (PSQIC5)	-0.68	2.11	-0.03	-0.32	0.75
Sleep Medication Usage (PSQIC6)	-2.11	1.45	-0.11	-1.45	0.15
Daytime Dysfunction (PSQIC7)	-1.80	1.47	-0.12	-1.22	0.22
PSQI Global	0.13	0.40	0.04	0.33	0.74
Fatigue Severity (FSS)	-0.18	0.11	-0.15	-1.57	0.12
Subjective Fatigue (CIS20-1)	-0.16	0.28	-0.13	-0.59	0.55
Reduced Concentration (CIS20-2)	-0.08	0.31	-0.04	-0.26	0.80
Total Fatigue (CIS20-Total)	0.08	0.17	0.13	0.48	0.64

Table 4.5 shows hierarchical multiple regression analysis between post-shift SBP and significant variables as determined by partial correlations; perceptions of stress (LAQ Part 2), frequency of sleep disturbances, sleep medication usage and daytime dysfunction (PSQI Components 5, 6 and 7 respectively), global PSQI score and fatigue severity (FSS), as well as subjective fatigue (CIS20-1), reduced concentration (CIS20-2) and total fatigue (CIS20-Total). The model also accounts for the covariates of age, sex, WHR and lifestyle risk factors for the total sample (N=255).

Key: CIS20 = Checklist of Individual Strength, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, SBP = Systolic Blood Pressure, WCQR = Ways of Coping Questionnaire Revised, WHR = Waist-Hip Ratio; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard; t = t statistic, < = Less than

DBP was found to have a number of significant relationships with the independent variables, after accounting for the effects of age, sex, WHR and lifestyle risk factors (LAQ Part 1) (Table 4.6). Pre-shift DBP showed negative relationships with perception of stress ($r=-0.20$, $p=0.001$), frequency of sleep disturbances ($r=-0.13$, $p=0.042$), daytime dysfunction ($r=-0.17$, $p=0.008$), global PSQI score ($r=-0.16$, $p=0.014$), sleepiness risk ($r=-0.13$, $p=0.049$), fatigue severity ($r=-0.27$, $p=0.001$) and reduced concentration ($r=-0.19$, $p=0.018$). A subsequent hierarchical multiple regression (Table 4.7) was performed using the significant correlations identified and was found to be overall significant for pre-shift DBP ($F(11,146) = 5.62$, $p<0.001$). Together the independent variables explain 30% of the variance in pre-shift DBP, with age ($p=0.026$), lifestyle risk factors ($p<0.001$) and fatigue severity ($p=0.044$) being the significant predictors.

Post-shift DBP was also found to have all the same significant negative correlations as pre-shift DBP, including perception of stress ($r=-0.24$, $p<0.001$), frequency of sleep disturbances ($r=-0.23$, $p<0.001$), daytime dysfunction ($r=-0.26$, $p<0.001$), global PSQI score ($r=-0.23$, $p<0.001$), sleepiness risk ($r=-0.18$, $p=0.005$), fatigue severity ($r=-0.32$, $p<0.001$) and reduced concentration ($r=-0.18$, $p=0.030$), as well as sleep medication usage ($r=-0.15$, $p=0.019$). A subsequent hierarchical multiple regression (Table 4.8) was performed using the significant correlations identified and was found to be overall significant for post-shift DBP ($F(12,145) = 5.06$, $p<0.001$). Together the independent variables explain 30% of the variance in post-shift DBP, with only the covariate of lifestyle risk factors ($p<0.001$) being a significant predictor.

Finally, DBP reactivity was found to be positively correlated with Accepting Responsibility coping style prevalence ($r=0.17$, $p=0.039$) and negatively associated with subjective sleep quality ($r=-0.13$, $p=0.037$), frequency of sleep disturbances ($r=-0.15$, $p=0.016$), daytime dysfunction ($r=-0.14$, $p=0.029$) and TTW ($r=-0.20$, $p=0.015$). A subsequent hierarchical multiple regression (Table 4.9) performed using the significant correlations identified and was found to be trending towards significance for DBP reactivity ($F(9,143) = 1.76$, $p=0.08$). Together the independent variables explain 10% of the variance in DBP reactivity, with only the covariate of Accepting Responsibility coping style prevalence ($p=0.021$) being a significant predictor.

Table 4.6 – Significant partial correlations between independent variables and DBP for the total sample (N=255)

	Independent Variables	Pre-Shift DBP		Post-Shift DBP		DBP Reactivity	
		r	*p*	*r*	*p*	*r*	*p*
Total sample (N=255)	Perception of Stress (LAQ Part 2)	-0.20	**0.001**	-0.24	**<0.001**	-	-
	Subjective Sleep Quality (PSQIC1)	-	-	-	-	-0.13	**0.037**
	Sleep Disturbances (PSQIC5)	-0.13	**0.042**	-0.23	**<0.001**	-0.15	**0.016**
	Sleep Medication Usage (PSQIC6)	-	-	-0.15	**0.019**	-	-
	Daytime Dysfunction (PSQIC7)	-0.17	**0.008**	-0.26	**<0.001**	-0.14	**0.029**
	PSQI Global	-0.16	**0.014**	-0.23	**<0.001**	-	-
	Sleepiness Risk (ESS)	-0.13	**0.049**	-0.18	**0.005**	-	-
	Fatigue Severity (FSS)	-0.27	**0.001**	-0.32	**<0.001**	-	-
	TTW	-	-	-	-	-0.20	**0.015**
	Accepting Responsibility (WCQR5)	-	-	-	-	0.17	**0.039**
	Reduced Concentration (CIS20)	-0.19	**0.018**	-0.18	**0.030**	-	-

Table 4.6 shows significant results from partial Pearson's correlations between DBP and other independent variables for the total sample (N=255), accounting for the effects of age, sex, WHR and lifestyle risk factors.

Key: CIS20 = Checklist of Individual Strength DBP = Diastolic Blood Pressure, ESS = Epworth Sleepiness Scale, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, TTW = Total Travel Work Time, WCQR = Ways of Coping Questionnaire Revised; p = Level of statistical significance (p=<0.05 (in bold)), - = Not significant

Table 4.7 – Hierarchical multiple regression between pre-shift DBP and significantly correlated variables in the total sample (N=255)

Total Sample (N=255)	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**p**
Pre-Shift DBP	0.55	0.30	0.24	7.61	**<0.001**
	B	**Std. Error**	**Beta**	**t**	**p**
(Constant)	58.78	10.69		5.50	**<0.001**
Age	0.19	0.09	0.19	2.25	**0.026**
Sex	-0.47	1.62	-0.02	-0.29	0.77
WHR	16.13	11.35	0.14	1.42	0.16
Lifestyle Risk Factors (LAQ Part 1)	0.49	0.12	0.33	3.96	**<0.001**
Perception of Stress (LAQ Part 2)	-0.08	0.10	-0.08	-0.78	0.44
Sleep Disturbances (PSQIC5)	0.31	1.48	0.02	0.21	0.84
Daytime Dysfunction (PSQIC7)	-0.05	1.07	-0.01	-0.05	0.96
PSQI Global	-0.04	0.26	-0.02	-0.17	0.87
Sleepiness Risk (ESS)	-0.06	0.18	-0.03	-0.36	0.72
Fatigue Severity (FSS)	-0.16	0.08	-0.19	-2.03	**0.044**
Reduced Concentration (CIS20-2)	-0.02	0.17	-0.01	-0.09	0.93

Table 4.7 shows hierarchical multiple regression analysis between pre-shift DBP and significant variables as determined by partial correlations; perceptions of stress (LAQ Part 2), frequency of sleep disturbances and daytime dysfunction (PSQI Components 5 and 7 respectively), global PSQI score, sleepiness risk (ESS) and fatigue severity (FSS), as well as reduced concentration (CIS20-2). The model also accounts for the covariates of age, sex, WHR and lifestyle risk factors for the total sample (N=255).

Key: CIS20 = Checklist of Individual Strength, DBP = Diastolic Blood Pressure, ESS = Epworth Sleepiness Scale, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, WCQR = Ways of Coping Questionnaire Revised, WHR = Waist-Hip Ratio; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Table 4.8 – Hierarchical multiple regression between post-shift DBP and significantly correlated variables in the total sample (N=255)

Total Sample (N=255)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Post-Shift DBP	0.54	0.30	0.24	7.97	**<0.001**
	B	Std. Error	Beta	t	p
(Constant)	59.87	11.21		5.34	**<0.001**
Age	0.15	0.09	0.14	1.68	0.10
Sex	-0.34	1.70	-0.02	-0.20	0.84
WHR	16.94	11.89	0.14	1.43	0.16
Lifestyle Risk Factors (LAQ Part 1)	0.53	0.13	0.35	4.12	**<0.001**
Perception of Stress (LAQ Part 2)	-0.13	0.11	-0.13	-1.23	0.22
Sleep Disturbances (PSQIC5)	-1.10	1.56	-0.07	-0.71	0.48
Sleep Medication Usage (PSQIC6)	-1.46	1.09	-0.11	-1.34	0.18
Daytime Dysfunction (PSQIC7)	-0.98	1.14	-0.09	-0.86	0.39
PSQI Global	-0.02	0.30	-0.01	-0.05	0.96
Sleepiness Risk (ESS)	-0.05	0.19	-0.02	-0.28	0.78
Fatigue Severity (FSS)	-0.17	0.08	-0.19	-1.98	0.05
Reduced Concentration (CIS20-2)	0.14	0.18	0.09	0.82	0.42

Table 4.8 shows hierarchical multiple regression analysis between post-shift DBP and significant variables as determined by partial correlations; perceptions of stress (LAQ Part 2), frequency of sleep disturbances, sleep medication usage and daytime dysfunction (PSQI Components 5, 6 and 7 respectively), global PSQI score, sleepiness risk (ESS) and fatigue severity (FSS), as well as reduced concentration (CIS20-2). The model also accounts for the covariates of age, sex, WHR and lifestyle risk factors for the total sample (N=255).

Key: CIS20 = Checklist of Individual Strength, DBP = Diastolic Blood Pressure, ESS = Epworth Sleepiness Scale, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, WCQR = Ways of Coping Questionnaire Revised, WHR = Waist-Hip Ratio; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Table 4.9 – Hierarchical multiple regression between DBP reactivity and significantly correlated variables in the total sample (N=255)

Total Sample (N=255)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
DBP Reactivity	0.32	0.100	0.043	5.97059	0.08
	B	**Std. Error**	**Beta**	**t**	**P**
(Constant)	0.42	8.25		0.05	0.96
Age	-0.01	0.07	-0.01	-0.15	0.89
Sex	-0.09	1.26	-0.01	-0.07	0.95
WHR	0.62	8.75	0.01	0.07	0.94
Lifestyle Risk Factors (LAQ Part 1)	0.00	0.09	0.00	0.04	0.97
Subjective Sleep Quality (PSQIC1)	-0.36	0.77	-0.05	-0.47	0.64
Sleep Disturbances (PSQIC5)	-1.17	1.11	-0.10	-1.05	0.30
Daytime Dysfunction (PSQIC7)	-0.55	0.72	-0.07	-0.76	0.45
TTW	-0.00	0.00	-0.15	-1.78	0.08
Accepting Responsibility (WCQR5)	0.42	0.18	0.20	2.33	**0.021**

Table 4.9 shows hierarchical multiple regression analysis between DBP reactivity and significant variables as determined by partial correlations; subjective sleep quality, frequency of sleep disturbances and daytime dysfunction (PSQI Components 1, 5 and 7 respectively), TTW and prevalence of the 'Accepting Responsibility' coping mechanism (WCQR5). The model also accounts for the covariates of age, sex, WHR and lifestyle risk factors for the total sample (N=255).

Key: DBP = Diastolic Blood Pressure, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, TTW = Total Travel Work Time, WCQR = Ways of Coping Questionnaire Revised, WHR = Waist-Hip Ratio; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

4.1.2 Results: Blood Pressure and Shift work (sex comparison)

This section presents the results in the context of comparing the sexes; 179 male and 76 female general duties police officers made up the total sample (N=255). Their demographics, BP, associated correlations and regression analyses follow.

4.1.2.1 Demographics (sex comparison)

Mean (± SD) demographics for male (n=179) and female (n=76) police officers are provided in Table 4.10. Independent sample t-tests performed found males had a significantly higher mean age (p=0.007), longer years of service (p=0.049) and larger WHR (p<0.001) compared to their female peers. Both groups' LAQ Part 1 scores were below the normative threshold value suggested by Craig and colleagues (1996).

Table 4.10 – Mean demographic values for male (n=179) and female (n=76) police officers

Demographics	Male (n=179)	Female (n=76)	p
Years of Age	32.22 ± 8.76	29.16 ± 7.83	**0.007**
Years of Service	7.16 ± 8.08	5.24 ± 6.63	**0.049**
WHR	0.88 ± 0.06	0.79 ± 0.06	**<0.001**
TTW	310.29 ± 209.76	325.69 ± 278.51	-
Lifestyle Risk Factors (LAQ Part 1)	13.18 ± 6.18	12.58 ± 5.38	-

Table 4.10 shows mean demographic scores (presented as mean ± SD) for the male and female general duties police officers (n=179 and n=76 respectively). Independent sample t-tests were performed, with age, years of service and WHR all being significantly different based on sex. Total travel work time (TTW) was calculated by averaging the hours required to travel to and from work across the course of the average week. The maximum score for the LAQ Part 1 (lifestyle risk factors) is 70, with greater scores indicating an increased likelihood of developing a chronic illness (Craig et al., 1996).

Key: LAQ = Lifestyle Appraisal Questionnaire, TTW = Total Travel Work Time, WHR = Waist-Hip Ratio; n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), SD = Standard Deviation, ± = Plus and minus, - = Not significant

4.1.2.2 Blood Pressure (sex comparison)

Mean (± SD) BP values for male (n=179) and female (n=76) police officers are provided in Table 4.11. Paired sample t-tests revealed female officers' SBP increased significantly increased from pre to post-shift (p<0.001). Independent sample t-tests performed also identified all cardiac values recorded, except DBP reactivity, significantly differed between the sexes (p<0.010), with males having higher pre and post-shift SBP and DBP, as well as smaller SBP reactivity, than their female counterparts.

Table 4.11 – Mean cardiac values for male (n=179) and female (n=76) police officers

Variables	**Male (n=179)**		**Female (n=76)**	
	SBP (mmHg ± SD)	DBP (mmHg ± SD)	SBP (mmHg ± SD)	DBP (mmHg ± SD)
Pre-Shift	132.07 ± 10.57*	77.67 ± 8.65*	117.43 ± 10.39	74.37 ± 8.62
Post-Shift	132.45 ± 11.29*	77.78 ± 9.30*	120.54 ± 10.42	74.03 ± 8.16
BP Reactivity	0.38 ± 8.48*	0.11 ± 6.07	3.11 ± 6.94	-0.34 ± 6.22
p	-	-	**<0.001**	-

Table 4.11 shows mean cardiac values for the male and female general duties police officers (n=179 and n=76 respectively). BP was taken before and after the subjects' regular shift, with reactivity calculated by deducting the pre-shift from the post-shift result. Dependant sample t-tests were performed and only female officers' SBP was found to be significantly greater after shift. Independent sample t-tests were performed and all cardiac variables, except DBP reactivity, significantly differed based on sex (p<0.010).

Key: BP = Blood Pressure, DBP = Diastolic Blood Pressure, SBP = Systolic Blood Pressure; mmHg = Millimetres of mercury, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), SD =Standard Deviation, ± = Plus and minus, - = Not significant, * = Significant independent t-test result (p<0.010)

4.1.2.3 Blood Pressure Associations & Regression Analyses (sex comparison)

Partial correlations were performed to identify the relationship between male and females' BP and other independent variables. The covariates accounted for were age, WHR and lifestyle risk factors (LAQ Part 1), detailed in Section 4.1.1.3. Where three or more independent variables were found to be significantly correlated with the dependant variable of BP, consequent hierarchical multiple regressions were performed.

Pre-shift SBP was found to have a number of significant relationships with other independent variables when comparing between the sexes, after accounting for the effects of age, WHR and lifestyle risk factors (LAQ Part 1) (Table 4.12). Males' pre-shift SBP was found to be negatively correlated with perception of stress ($r=-0.19$, $p=0.013$), sleep onset latency ($r=-0.15$, $p=0.048$), frequency of sleep disturbances ($r=-0.17$, $p=0.023$), daytime dysfunction ($r=-0.23$, $p=0.003$), global PSQI score ($r=-0.17$, $p=0.022$) and fatigue severity ($r=-0.19$, $p=0.049$), as well as subjective fatigue ($r=-0.29$, $p=0.003$) and reduced concentration, motivation and activity ($r=-0.22$, $p=0.024$; $r=-0.24$, $p=0.015$; $r=-0.20$, $p=0.043$ respectively). A subsequent hierarchical multiple regression (Table 4.13) was performed using the significant correlations identified and was found to be not statistically significant ($F(13,93) = 1.45$, $p=0.15$). Despite this, together the independent variables explain 17% of the variance in males' pre-shift SBP, with only the covariate of lifestyle risk factors ($p=0.003$) being a significant predictor.

By comparison, female officers' only significant correlation identified with pre-shift SBP was Seeking Social Support coping style prevalence ($r=-0.29$, $p=0.048$). As such, no regressions were performed for females' pre-shift SBP as there were less than three significant independent variables correlated.

Table 4.12 – Significant partial correlations between independent variables and pre-shift SBP for male (n=179) and female (n=76) police officers

Independent Variables	Pre-Shift SBP			
	Male (n=179)		Female (n=76)	
	r	*p*	*r*	*p*
Perception of Stress (LAQ Part 2)	-0.19	**0.013**	-	-
Sleep Onset Latency (PSQIC2)	-0.15	**0.048**	-	-
Sleep Disturbances (PSQIC5)	-0.17	**0.023**	-	-
Daytime Dysfunction (PSQIC7)	-0.23	**0.003**	-	-
PSQI Global	-0.17	**0.022**	-	-
Fatigue Severity (FSS)	-0.19	**0.049**	-	-
Seeking Social Support (WCQR4)	-	-	-0.29	**0.048**
Subjective Fatigue (CIS20-1)	-0.29	**0.003**	-	-
Reduced Concentration (CIS20-2)	-0.22	**0.024**	-	-
Reduced Motivation (CIS20-3)	-0.24	**0.015**	-	-
Reduced Activity (CIS20-4)	-0.20	**0.043**	-	-

Table 4.12 shows significant results from partial Pearson's correlations between pre-shift SBP and other independent variables for the male and female general duties police officers (n=179 and n=76 respectively), accounting for the effects of age, WHR and lifestyle risk factors.

Key: CIS20 = Checklist of Individual Strength, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, SBP = Systolic Blood Pressure, WCQR = Ways of Coping Questionnaire Revised; p = Level of statistical significance (p=<0.05 (in bold)), - = Not significant

Table 4.13 – Hierarchical multiple regression between pre-shift SBP and significantly correlated variables in male police officers (n=179)

Male (n=179)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Pre-Shift SBP	0.41	0.17	0.05	10.29	0.15
	B	**Std. Error**	**Beta**	**t**	**p**
(Constant)	121.65	17.13		7.10	**<0.001**
Age	-0.07	0.15	-0.06	-0.48	0.63
WHR	18.80	20.40	0.11	0.92	0.36
Lifestyle Risk Factors (LAQ Part 1)	0.65	0.22	0.39	3.07	**0.003**
Perception of Stress (LAQ Part 2)	0.06	0.18	0.05	0.35	0.73
Sleep Onset Latency (PSQIC2)	-1.05	1.78	-0.10	-0.59	0.56
Sleep Disturbances (PSQIC5)	-2.37	2.49	-0.13	-0.95	0.35
Daytime Dysfunction (PSQIC7)	-1.64	1.77	-0.13	-0.93	0.36
PSQI Global	0.56	0.62	0.18	0.90	0.37
Fatigue Severity (FSS)	0.04	0.14	0.04	0.27	0.79
Subjective Fatigue (CIS20-1)	-0.23	0.22	-0.21	-1.06	0.29
Reduced Concentration (CIS20-2)	-0.12	0.30	-0.07	-0.39	0.70
Reduced Motivation (CIS20-3)	-0.26	0.38	-0.10	-0.68	0.50
Reduced Activity (CIS20-4)	-0.18	0.37	-0.06	-0.48	0.63

Table 4.13 shows hierarchical multiple regression analysis between pre-shift SBP and significant variables as determined by partial correlations; perceptions of stress (LAQ Part 2), sleep onset latency, frequency of sleep disturbances and daytime dysfunction (PSQI Components 2, 5 and 7 respectively), global PSQI score and fatigue severity (FSS), as well as subjective fatigue, reduced concentration, motivation and activity (CIS20). The model also accounts for the covariates of age, WHR and lifestyle risk factors for the male general duties police officers (n=179).

Key: CIS20 = Checklist of Individual Strength, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, SBP = Systolic Blood Pressure, WHR = Waist-Hip Ratio; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Post-shift SBP was found to share a number of similar negative relationships with pre-shift SBP when comparing between the sexes (Table 4.14). Males' post-shift SBP was again negatively correlated with perception of stress ($r=-0.20$, $p=0.007$), sleep onset latency ($r=-0.17$, $p=0.021$), frequency of sleep disturbances ($r=-0.22$, $p=0.003$), daytime dysfunction ($r=-0.28$, $p<0.001$), global PSQI score ($r=-0.26$, $p<0.001$), fatigue severity ($r=-0.19$, $p=0.049$), subjective fatigue ($r=-0.31$, $p=0.002$), reduced concentration ($r=-0.25$, $p=0.009$) and reduced motivation ($r=-0.22$, $p=0.023$), as well as subjective sleep quality ($r=-0.15$, $p=0.042$). A subsequent hierarchical multiple regression (Table 4.15) was performed using the significant correlations identified and was found to be overall significant for post-shift SBP ($F(14,92) = 1.90$, $p=0.036$). Together the independent variables explain 22% of the variance in males' post-shift SBP, with only the covariate of lifestyle risk factors ($p<0.001$) being a significant predictor.

By comparison, female officers' only significant correlation identified with post-shift SBP was sleepiness risk ($r=-0.33$, $p=0.005$). As such, no regressions were performed for females' post-shift SBP as there were less than three significant independent variables correlated.

Table 4.14 – Significant partial correlations between independent variables and post-shift SBP for male (n=179) and female (n=76) police officers

Independent Variables	Post-Shift SBP (mmHg ± SD)			
	Male (n=179)		Female (n=76)	
	r	*p*	*r*	*p*
Perception of Stress (LAQ Part 2)	-0.20	**0.007**	-	-
Subjective Sleep Quality (PSQIC1)	-0.15	**0.042**	-	-
Sleep Onset Latency (PSQIC2)	-0.17	**0.021**	-	-
Sleep Disturbances (PSQIC5)	-0.22	**0.003**	-	-
Sleep Medication Usage (PSQIC6)	-0.18	**0.019**	-	-
Daytime Dysfunction (PSQIC7)	-0.28	**<0.001**	-	-
PSQI Global	-0.26	**<0.001**	-	-
Sleepiness Risk (ESS)	-	-	-0.33	**0.005**
Fatigue Severity (FSS)	-0.31	**0.002**	-	-
Subjective Fatigue (CIS20-1)	-0.35	**<0.001**	-	-
Reduced Concentration (CIS20-2)	-0.25	**0.009**	-	-
Reduced Motivation (CIS20-3)	-0.22	**0.023**	-	-

Table 4.14 shows significant results from partial Pearson's correlations between post-shift SBP and other independent variables for the male and female general duties police officers (n=179 and n=76 respectively), accounting for the effects of age, WHR and lifestyle risk factors.

Key: CIS20 = Checklist of Individual Strength, ESS = Epworth Sleepiness Scale, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, SBP = Systolic Blood Pressure; mmHg = Millimetres of mercury, p = Level of statistical significance (p=<0.05 (in bold)), SD = Standard Deviation, - = Not significant

Table 4.15 – Hierarchical multiple regression between post-shift SBP and significantly correlated variables in male police officers (n=179)

Male (n=179)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Post-Shift SBP	0.47	0.22	0.11	10.67	**0.036**
	B	**Std. Error**	**Beta**	**T**	**P**
(Constant)	141.15	17.84		7.91	**<0.001**
Age	0.07	0.16	0.05	0.44	0.66
WHR	-8.52	21.24	-0.05	-0.40	0.69
Lifestyle Risk Factors (LAQ Part 1)	0.86	0.22	0.47	3.84	**<0.001**
Perception of Stress (LAQ Part 2)	0.10	0.18	0.08	0.53	0.60
Subjective Sleep Quality (PSQIC1)	1.49	2.27	0.10	0.66	0.51
Sleep Onset Latency (PSQIC2)	-0.89	1.86	-0.08	-0.48	0.63
Sleep Disturbances (PSQIC5)	-1.90	2.60	-0.10	-0.73	0.47
Sleep Medication Usage (PSQIC6)	-2.39	2.02	-0.12	-1.18	0.24
Daytime Dysfunction (PSQIC7)	-1.74	1.90	-0.13	-0.92	0.36
PSQI Global	0.10	0.83	0.03	0.12	0.91
Fatigue Severity (FSS)	-0.08	0.15	-0.07	-0.54	0.59
Subjective Fatigue (CIS20-1)	-0.31	0.22	-0.27	-1.39	0.17
Reduced Concentration (CIS20-2)	-0.02	0.33	-0.01	-0.06	0.95
Reduced Motivation (CIS20-3)	-0.14	0.38	-0.05	-0.37	0.71

Table 4.15 shows hierarchical multiple regression analysis between post-shift SBP and significant variables as determined by partial correlations; perceptions of stress (LAQ Part 2), subjective sleep quality, sleep onset latency, frequency of sleep disturbances, sleep medication usage and daytime dysfunction (PSQI Components 1, 2, 5, 6 and 7 respectively), global PSQI score and fatigue severity (FSS), as well as subjective fatigue, reduced concentration and motivation (CIS20). The model also accounts for the covariates of age, WHR and lifestyle risk factors for the male general duties police officers (n=179).

Key: CIS20 = Checklist of Individual Strength, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, SBP = Systolic Blood Pressure, WHR = Waist-Hip Ratio; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Finally, SBP reactivity (Table 4.16) was found to have a few significant associations, where males' SBP reactivity was positively correlated with Distancing coping style prevalence (r=0.26, p=0.008) and negatively associated with sleep medication usage (r=-0.19, p=0.013). By comparison, females' SBP reactivity negatively correlated with sleepiness risk (r=-0.39, p=0.001) and TTW (r=-0.32, p=0.028). As such, no regressions were performed for male or females' SBP reactivity as there were less than three significant independent variables correlated for either sex.

Table 4.16 – Significant partial correlations between independent variables and SBP reactivity for male (n=179) and female (n=76) police officers

Independent Variables	SBP Reactivity			
	Male (n=179)		Female (n=76)	
	r	*p*	*r*	*p*
Sleep Medication Usage (PSQIC6)	-0.19	**0.013**	-	-
Sleepiness Risk (ESS)	-	-	-0.39	**0.001**
TTW	-	-	-0.32	**0.028**
Distancing (WCQR2)	0.26	**0.008**	-	-

Table 4.16 shows significant results from partial Pearson's correlations between SBP reactivity and other independent variables for the male and female general duties police officers (n=179 and n=76 respectively), accounting for the effects of age, WHR and lifestyle risk factors.

Key: ESS = Epworth Sleepiness Scale, PSQIC = Pittsburgh Sleep Quality Index Component, SBP = Systolic Blood Pressure, TTW = Total Travel Work Time, WCQR = Ways of Coping Questionnaire Revised; p = Level of statistical significance (p=<0.05 (in bold)), - = Not significant

Pre-shift DBP was found to have a number of significant relationships with other independent variables when comparing between the sexes, after accounting for the effects of age, WHR and lifestyle risk factors (LAQ Part 1) (Table 4.17). Males' pre-shift SBP was found to be positively correlated with TTW ($r=0.23$, $p=0.022$) and negatively associated with perception of stress ($r=-0.22$, $p=0.003$), sleep onset latency ($r=-0.21$, $p=0.006$), daytime dysfunction ($r=-0.19$, $p=0.012$), global PSQI score ($r=-0.21$, $p=0.006$), sleepiness risk ($r=-0.19$, $p=0.011$), fatigue severity ($r=-0.29$, $p=0.003$), subjective fatigue ($r=-0.24$, $p=0.036$) and reduced concentration ($r=-0.21$, $p=0.036$). A subsequent hierarchical multiple regression (Table 4.18) was performed using the significant correlations identified and was found to be overall significant for males' pre-shift DBP ($F(12,89) = 4.89$, $p<0.001$). Together the independent variables explain 40% of the variance in pre-shift DBP, with WHR ($p=0.036$), lifestyle risk factors ($p<0.001$) and TTW ($p=0.009$) being the significant predictors.

By comparison, female officers' pre-shift DBP was found to significantly negatively correlate with Distancing ($r=-0.29$, $p=0.044$) and Self-Controlling coping style prevalence ($r=-0.31$, $p=0.035$). As such, no regressions were performed for females' pre-shift DBP as there were less than three significant independent variables correlated.

Table 4.17 – Significant partial correlations between independent variables and pre-shift DBP for male (n=179) and female (n=76) police officers

Independent Variables	Pre-Shift DBP			
	Male (n=179)		Female (n=76)	
	r	*p*	*r*	*p*
Perception of Stress (LAQ Part 2)	-0.22	**0.003**	-	-
Sleep Onset Latency (PSQIC2)	-0.21	**0.006**	-	-
Daytime Dysfunction (PSQIC7)	-0.19	**0.012**	-	-
PSQI Global	-0.21	**0.006**	-	-
Sleepiness Risk (ESS)	-0.19	**0.011**	-	-
Fatigue Severity (FSS)	-0.29	**0.003**	-	-
TTW	0.23	**0.022**	-	-
Distancing (WCQR2)	-	-	-0.29	**0.044**
Self-Controlling (WCQR3)	-	-	-0.31	**0.035**
Subjective Fatigue (CIS20-1)	-0.24	**0.036**	-	-
Reduced Concentration (CIS20-2)	-0.21	**0.036**	-	-

Table 4.17 shows significant results from partial Pearson's correlations between pre-shift DBP and other independent variables for the male and female general duties police officers (n=179 and n=76 respectively), accounting for the effects of age, WHR and lifestyle risk factors.

Key: CIS20 = Checklist of Individual Strength, DBP = Diastolic Blood Pressure, ESS = Epworth Sleepiness Scale, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, TTW = Total Travel Work Time, WCQR = Ways of Coping Questionnaire Revised; p = Level of statistical significance (p=<0.05 (in bold)), - = Not significant

Table 4.18 – Hierarchical multiple regression between pre-shift DBP and significantly correlated variables in male police officers (n=179)

Male (n=179)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Pre-Shift DBP	0.63	0.40	0.32	7.15	**<0.001**
	B	**Std. Error**	**Beta**	**t**	**p**
(Constant)	44.54	11.86		3.75	**<0.001**
Age	0.15	0.10	0.15	1.49	0.14
WHR	30.22	14.16	0.22	2.13	**0.036**
Lifestyle Risk Factors (LAQ Part 1)	0.59	0.15	0.42	3.88	**<0.001**
Perception of Stress (LAQ Part 2)	-0.08	0.12	-0.09	-0.69	0.49
Sleep Onset Latency (PSQIC2)	-1.31	1.20	-0.15	-1.09	0.28
Daytime Dysfunction (PSQIC7)	0.43	1.27	0.04	0.34	0.74
PSQI Global	0.10	0.40	0.04	0.26	0.80
Sleepiness Risk (ESS)	-0.28	0.21	-0.14	-1.34	0.18
Fatigue Severity (FSS)	-0.10	0.10	-0.12	-1.01	0.32
TTW	0.01	0.00	0.23	2.66	**0.009**
Subjective Fatigue (CIS20-1)	-0.09	0.14	-0.11	-0.67	0.51
Reduced Concentration (CIS20-2)	0.06	0.22	0.04	0.30	0.76

Table 4.18 shows hierarchical multiple regression analysis between pre-shift DBP and significant variables as determined by partial correlations; perceptions of stress (LAQ Part 2), sleep onset latency and daytime dysfunction (PSQI Components 2 and 7 respectively), global PSQI score, sleepiness risk (ESS) and fatigue severity (FSS), total travel work time (TTW), as well as subjective fatigue and reduced concentration (CIS20). The model also accounts for the covariates of age, WHR and lifestyle risk factors for the male general duties police officers (n=179).

Key: CIS20 = Checklist of Individual Strength, DBP = Diastolic Blood Pressure, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, WHR = Waist-Hip Ratio; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Post-shift DBP was found to share a number of similar negative relationships with pre-shift SBP when comparing between the sexes (Table 4.19). Males' post-shift SBP was again negatively correlated with perception of stress (r=-0.30, p<0.001), sleep onset latency (r=-0.27, p<0.001), daytime dysfunction (r=-0.31, p<0.001), global PSQI score (r=-0.35, p<0.001), sleepiness risk (r=-0.18, p=0.019), fatigue severity (r=-0.40, p<0.001), subjective fatigue (r=-0.29, p=0.003) and reduced concentration (r=-0.27, p=0.006), as well as subjective sleep quality (r=-0.15, p=0.044), sleep duration (r=-0.17, p=0.023), frequency of sleep disturbances (r=-0.27, p<0.001) and sleep medication usage (r=-0.23, p=0.003). A subsequent hierarchical multiple regression (Table 4.20) was performed using the significant correlations identified and was found to be overall significant for post-shift SBP (F(15,91) = 4.25, p<0.001). Together the independent variables explain 41% of the variance in males' post-shift DBP, with the covariates of WHR (p=0.041) and lifestyle risk factors (p<0.001) being the significant predictors.

By comparison, female officers' post-shift DBP was found to be positively correlated with sleep onset latency (r=0.24, p=0.041), and negatively correlated with sleepiness risk (r=-0.26, p=0.027) and TTW (r=-0.30, p=0.039). A subsequent hierarchical multiple regression (Table 4.21) performed using the significant correlations identified and was found to be trending towards significance for post-shift DBP (F(6, 44) = 2.19, p=0.06). Together the independent variables explain 23% of the variance in females' post-shift DBP, with only the covariate of sleep onset latency (p=0.040) being a significant predictor.

Table 4.19 – Significant partial correlations between independent variables and post-shift DBP for male (n=179) and female (n=76) police officers

Independent Variables	**Post-Shift DBP**			
	Male (n=179)		**Female (n=76)**	
	r	***p***	***r***	***p***
Perception of Stress (LAQ Part 2)	-0.30	**<0.001**	-	-
Subjective Sleep Quality (PSQIC1)	-0.15	**0.044**	-	-
Sleep Onset Latency (PSQIC2)	-0.27	**<0.001**	0.24	**0.041**
Sleep Duration (PSQIC3)	-0.17	**0.023**	-	-
Sleep Disturbances (PSQIC5)	-0.27	**<0.001**	-	-
Sleep Medication Usage (PSQIC6)	-0.23	**0.003**	-	-
Daytime Dysfunction (PSQIC7)	-0.31	**<0.001**	-	-
PSQI Global	-0.35	**<0.001**	-	-
Sleepiness Risk (ESS)	-0.18	**0.019**	-0.26	**0.027**
Fatigue Severity (FSS)	-0.40	**<0.001**	-	-
TTW	-	**-**	-0.30	**0.039**
Subjective Fatigue (CIS20-1)	-0.29	**0.003**	-	-
Reduced Concentration (CIS20-2)	-0.27	**0.006**	-	-

Table 4.19 shows significant results from partial Pearson's correlations between post-shift DBP and other independent variables for the male and female general duties police officers (n=179 and n=76 respectively), accounting for the effects of age, WHR and lifestyle risk factors.

Key: CIS20 = Checklist of Individual Strength, DBP = Diastolic Blood Pressure, ESS = Epworth Sleepiness Scale, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, TTW = Total Travel Work Time, WCQR = Ways of Coping Questionnaire Revised; p = Level of statistical significance (p=<0.05 (in bold)), - = Not significant

Table 4.20 – Hierarchical multiple regression between post-shift DBP and significantly correlated variables in male police officers (n=179)

Male (n=179)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Post-Shift DBP	0.64	0.41	0.32	7.69	**<0.001**
	B	Std. Error	Beta	T	p
(Constant)	46.51	12.83		3.62	**<0.001**
Age	0.14	0.11	0.13	1.29	0.20
WHR	31.46	15.18	0.22	2.07	**0.041**
Lifestyle Risk Factors (LAQ Part 1)	0.67	0.16	0.45	4.17	**<0.001**
Perception of Stress (LAQ Part 2)	-0.22	0.13	-0.22	-1.62	0.11
Subjective Sleep Quality (PSQIC1)	1.73	1.76	0.14	0.99	0.33
Sleep Onset Latency (PSQIC2)	-2.19	1.62	-0.23	-1.35	0.18
Sleep Duration (PSQIC3)	-2.06	1.54	-0.21	-1.34	0.18
Sleep Disturbances (PSQIC5)	-1.82	2.04	-0.11	-0.89	0.37
Sleep Medication Usage (PSQIC6)	-3.20	1.68	-0.20	-1.90	0.06
Daytime Dysfunction (PSQIC7)	-1.86	1.64	-0.17	-1.14	0.26
PSQI Global	0.38	0.95	0.14	0.40	0.69
Sleepiness Risk (ESS)	-0.08	0.23	-0.04	-0.36	0.72
Fatigue Severity (FSS)	-0.16	0.11	-0.18	-1.49	0.14
Subjective Fatigue (CIS20-1)	0.01	0.15	0.01	0.04	0.97
Reduced Concentration (CIS20-2)	0.29	0.24	0.18	1.21	0.23

Table 4.20 shows hierarchical multiple regression analysis between post-shift DBP and significant variables as determined by partial correlations; perceptions of stress (LAQ Part 2), subjective sleep quality, sleep onset latency, sleep duration, frequency of sleep disturbances, sleep medication usage and daytime dysfunction (PSQI Components 1, 2, 3, 5, 6 and 7 respectively), global PSQI score, sleepiness risk (ESS) and fatigue severity (FSS), as well as subjective fatigue and reduced concentration (CIS20). The model also accounts for the covariates of age, WHR and lifestyle risk factors for the male general duties police officers (n=179).

Key: CIS20 = Checklist of Individual Strength, DBP = Diastolic Blood Pressure, ESS = Epworth Sleepiness Scale, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, WHR = Waist-Hip Ratio; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Table 4.21 – Hierarchical multiple regression between post-shift DBP and significantly correlated variables in female police officers (n=76)

Female (n=76)	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**p**
Post-Shift DBP	0.48	0.23	0.13	7.63	0.062
	B	**Std. Error**	**Beta**	**T**	**p**
(Constant)	78.89	16.08		4.91	**<0.001**
Age	0.11	0.15	0.11	0.76	0.45
WHR	-11.95	20.06	-0.09	-0.60	0.55
Lifestyle Risk Factors (LAQ Part 1)	0.25	0.21	0.16	1.19	0.24
Sleep Onset Latency (PSQIC2)	2.41	1.14	0.29	2.12	**0.040**
Sleepiness Risk (ESS)	-0.38	0.37	-0.17	-1.02	0.31
TTW	-0.01	0.00	-0.27	-1.74	0.09

Table 4.21 shows hierarchical multiple regression analysis between post-shift DBP and significant variables as determined by partial correlations; sleep onset latency (PCQIC2), sleepiness risk (ESS) and total travel work time (TTW). The model also accounts for the covariates of age, WHR and lifestyle risk factors for the female general duties police officers (n=76).

Key: DBP = Diastolic Blood Pressure, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, WHR = Waist-Hip Ratio; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Finally, DBP reactivity (Table 4.22) was found to have a number of significant associations when comparing between the sexes. Males' DBP reactivity was negatively correlated with subjective sleep quality (r=-0.19, p=0.011), frequency of sleep disturbances (r=-0.25, p=0.001), sleep medication usage (r=-0.21, p=0.006), daytime dysfunction (r=-0.19, p=0.012), global PSQI score (r=-0.22, p=0.003), fatigue severity (r=-0.21, p=0.036) and TTW (r=-0.21, p=0.035). A subsequent hierarchical multiple regression (Table 4.23) was performed and found to not be significant (F(10,91) = 1.61, p=0.12). Together the independent variables explain 15% of the variance in males' DBP reactivity, with only the covariate of sleep medication usage (p=0.045) being a significant predictor.

By comparison, females' DBP reactivity negatively correlated with sleepiness risk (r=-0.26, p=0.027), and positively associated with Self-Controlling (r=0.41, p=0.004) and Accepting Responsibility coping style prevalence (r=0.36, p=0.013). A subsequent hierarchical multiple regression (Table 4.24) was performed using the significant correlations identified and was found to be overall significant for DBP reactivity (F(6,44) = 2.74, p=0.024). Together the independent variables explain 27% of the variance in females' DBP reactivity, however none of the predictors were found to be significant.

Table 4.22 – Significant partial correlations between independent variables and DBP reactivity for male (n=179) and female (n=76) police officers

Independent Variables	DBP Reactivity			
	Male (n=179)		Female (n=76)	
	r	*p*	*r*	*p*
Subjective Sleep Quality (PSQIC1)	-0.19	**0.011**	-	-
Sleep Disturbances (PSQIC5)	-0.25	**0.001**	-	-
Sleep Medication Usage (PSQIC6)	-0.21	**0.006**	-	-
Daytime Dysfunction (PSQIC7)	-0.19	**0.012**	-	-
PSQI Global	-0.22	**0.003**	-	-
Sleepiness Risk (ESS)	-	-	-0.26	**0.027**
Fatigue Severity (FSS)	-0.21	**0.036**	-	-
TTW	-0.21	**0.035**	-	-
Self-Controlling (WCQR3)	-	-	0.41	**0.004**
Accepting Responsibility (WCQR5)	-	-	0.36	**0.013**

Table 4.22 shows significant results from partial Pearson's correlations between DBP reactivity and other independent variables for the male and female general duties police officers (n=179 and n=76 respectively), accounting for the effects of age, WHR and lifestyle risk factors.

Key: CIS20 = Checklist of Individual Strength, DBP = Diastolic Blood Pressure, ESS = Epworth Sleepiness Scale, FSS = Fatigue Severity Scale, PSQIC = Pittsburgh Sleep Quality Index Component, TTW = Total Travel Work Time, WCQR = Ways of Coping Questionnaire Revised; p = Level of statistical significance (p=<0.05 (in bold)), - = Not significant

Table 4.23 – Hierarchical multiple regression between DBP reactivity and significantly correlated variables in male police officers (n=179)

Male (n=179)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
DBP Reactivity	0.39	0.15	0.06	5.89	0.115
	B	**Std. Error**	**Beta**	**T**	**p**
(Constant)	10.05	8.81		1.14	0.26
Age	0.01	0.08	0.02	0.16	0.87
WHR	-6.36	10.60	-0.07	-0.60	0.55
Lifestyle Risk Factors (LAQ Part 1)	0.07	0.11	0.07	0.64	0.52
Subjective Sleep Quality (PSQIC1)	-0.06	1.22	-0.01	-0.05	0.96
Sleep Disturbances (PSQIC5)	-1.15	1.45	-0.11	-0.79	0.43
Sleep Medication Usage (PSQIC6)	-2.22	1.09	-0.21	-2.03	**0.045**
Daytime Dysfunction (PSQIC7)	-0.87	1.01	-0.12	-0.86	0.39
PSQI Global	-0.02	0.34	-0.01	-0.07	0.95
Fatigue Severity (FSS)	-0.03	0.08	-0.05	-0.38	0.71
TTW	-0.01	0.00	-0.21	-1.96	0.05

Table 4.23 shows hierarchical multiple regression analysis between DBP reactivity and significant variables as determined by partial correlations; subjective sleep quality, frequency of sleep disturbances, sleep medication usage and daytime dysfunction (PSQI Components 1, 5, 6 and 7 respectively), global PSQI score and fatigue severity (FSS), as well as total travel work time (TTW). The model also accounts for the covariates of age, WHR and lifestyle risk factors for the male general duties police officers (n=179).

Key: DBP = Diastolic Blood Pressure, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, TTW = Total Travel Work Time, WHR = Waist-Hip Ratio; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Table 4.24 – Hierarchical multiple regression between DBP reactivity and significantly correlated variables in female police officers (n=76)

Female (n=76)	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**p**
DBP Reactivity	0.52	0.27	0.17	5.66	**0.024**
	B	**Std. Error**	**Beta**	**T**	**p**
(Constant)	-1.70	13.06		-0.13	0.90
Age	-0.18	0.11	-0.23	-1.66	0.10
WHR	-0.29	14.67	0.00	-0.02	0.98
Lifestyle Risk Factors (LAQ Part 1)	-0.10	0.16	-0.09	-0.67	0.51
Sleepiness Risk (ESS)	-0.34	0.25	-0.20	-1.36	0.18
Self-Controlling (WCQR3)	0.47	0.30	0.24	1.57	0.12
Accepting Responsibility (WCQR5)	0.49	0.32	0.23	1.54	0.13

Table 4.24 shows hierarchical multiple regression analysis between DBP reactivity and significant variables as determined by partial correlations; sleepiness risk (ESS), Self-Controlling and Accepting Responsibility prevalence (WCQR). The model also accounts for the covariates of age, WHR and lifestyle risk factors for the female general duties police officers (n=76).

Key: DBP = Diastolic Blood Pressure, ESS = Epworth Sleepiness Scale, LAQ = Lifestyle Appraisal Questionnaire, WCQR = Ways of Coping Questionnaire Revised, WHR = Waist-Hip Ratio; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

4.1.3 Results: Blood Pressure and Shift work (shift comparison)

This section presents the results in the context of comparing the general duties police officers based on the shift they were working at time of assessment; 148 were working a day shift (0600 – 1800) and 107 were working a night shift (1800 – 0600) that comprise the total sample (N=255). Their demographics, BP, associated correlations and regression analyses follow.

4.1.3.1 Demographics (shift comparison)

Mean (± SD) demographics for police officers working a day shift (n=148) or night shift (n=107) are provided in Table 4.25. Independent sample t-tests performed found those officers working a night shift had a significantly higher mean age (p=0.014) and larger WHR (p=0.010) than their day-rostered peers. Both groups' LAQ Part 1 scores were below the normative threshold value suggested by Craig and colleagues (1996).

Table 4.25 – Mean demographic values for police officers working a day (n=148) or night shift (n=107)

Demographics	Day (n=148)	Night (n=107)	p
Years of Age	30.18 ± 8.08	32.86 ± 9.06	**0.014**
Years of Service	6.22 ± 7.47	7.10 ± 8.05	-
WHR	0.84 ± 0.07	0.86 ± 0.07	**0.010**
TTW	330.94 ± 220.37	289.66 ± 254.76	-
Lifestyle Risk Factors (LAQ Part 1)	12.59 ± 5.50	13.56 ± 6.50	-

Table 4.25 shows mean demographic scores (presented as mean ± SD) for the general duties police officers working a day or night shift (n=148 and n=107 respectively). Independent sample t-tests were performed, with age and WHR being significantly different based on shift. Total travel work time (TTW) was calculated by averaging the hours required to travel to and from work across the course of the average week. The maximum score for the LAQ Part 1 (lifestyle risk factors) is 70, with greater scores indicating an increased likelihood of developing a chronic illness (Craig et al., 1996).

Key: LAQ = Lifestyle Appraisal Questionnaire, TTW = Total Travel Work Time, WHR = Waist-Hip Ratio; n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), SD = Standard Deviation, ± = Plus and minus, - = Not significant

4.1.3.2 Blood Pressure (shift comparison)

Mean (± SD) BP values for police officers working a day shift (n=148) or night shift (n=107) are provided in Table 4.26. Paired sample t-tests found only those officers working a day shift experienced a significant increase in SBP from pre to post-shift ($p<0.001$), while officers working at night's increase in SBP was trending towards significance ($p=0.07$). Independent sample t-tests performed also identified the mean pre-shift SBP and DBP to be significantly higher for officers working during the night, as well as having a lesser change in SBP, than those working a day shift ($p<0.010$).

Table 4.26 – Mean cardiac values for police officers working a day (n=148) or night shift (n=107)

Variables	Day (n=148)		Night (n=107)	
	SBP (mmHg ± SD)	DBP (mmHg ± SD)	SBP (mmHg ± SD)	DBP (mmHg ± SD)
Pre-Shift	125.61 ± 12.12*	75.59 ± 8.20*	130.62 ± 12.38	78.21 ± 9.31
Post-Shift	128.68 ± 12.19	76.03 ± 8.87	129.21 ± 12.48	77.52 ± 9.42
BP Reactivity	3.07 ± 7.84*	0.45 ± 5.91	-1.41 ± 7.85	-0.68 ± 6.33
p	**<0.001**	-	0.07	-

Table 4.26 shows mean cardiac values for the general duties police officers working a day or night shift (n=148 and n=107 respectively). BP was taken before and after the subjects' regular shift, with reactivity calculated by deducting the pre-shift from the post-shift result. Dependant sample t-tests performed found only day shift working police officers' SBP to be significantly greater after shift, while night officers' SBP was trending towards significance. Independent sample t-tests performed found pre-shift SBP and DBP, as well as SBP reactivity, significantly differed based on shift ($p<0.010$).

Key: BP = Blood Pressure, DBP = Diastolic Blood Pressure, SBP = Systolic Blood Pressure; mmHg = Millimetres of mercury, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), SD =Standard Deviation, ± = Plus and minus, - = Not significant, * = Significant independent t-test result ($p<0.010$)

4.1.3.3 Blood Pressure Associations & Regression Analyses (shift comparison)

Partial correlations were performed to identify the relationship between police officers' BP and other independent variables depending on working a day or night shift. The covariates accounted for were age, sex, WHR and lifestyle risk factors (LAQ Part 1), detailed in Section 4.1.1.3. Where three or more independent variables were found to be significantly correlated with the dependant variable of BP, consequent hierarchical multiple regressions were performed.

Pre-shift SBP was found to have a number of significant relationships with other independent variables when comparing between shifts, after accounting for the effects of age, sex, WHR and lifestyle risk factors (LAQ Part 1) (Table 4.27). While officers working the day shift were found to have no significant correlations, those working at night's pre-shift SBP was negatively correlated with perception of stress ($r=-0.21$, $p=0.038$), frequency of sleep disturbances ($r=-0.20$, $p=0.044$), fatigue severity ($r=-0.30$, $p=0.023$) and Escape-Avoidance coping style prevalence ($r=-0.34$, $p=0.012$). A subsequent hierarchical multiple regression (Table 4.28) was performed using the significant correlations identified and was found to be overall significant for pre-shift SBP ($F(8,51) = 3.46$, $p=0.003$). Together the independent variables explain 35% of the variance in night-shift working officers' pre-shift SBP, with only the covariate of sex ($p=0.022$) being a significant predictor.

Table 4.27 – Significant partial correlations between independent variables and pre-shift SBP for police officers working a day (n=148) or night shift (n=107)

Independent Variables	Pre-Shift SBP			
	Day (n=148)		Night (n=107)	
	r	*p*	*r*	*p*
Perception of Stress (LAQ Part 2)	-	-	-0.21	**0.038**
Sleep Disturbances (PSQIC5)	-	-	-0.20	**0.044**
Fatigue Severity (FSS)	-	-	-0.30	**0.023**
Escape-Avoidance (WCQR6)	-	-	-0.34	**0.012**

Table 4.27 shows significant results from partial Pearson's correlations between pre-shift SBP and other independent variables for the police officers working a day (n=148) or night shift (n=107), accounting for the effects of age, sex, WHR and lifestyle risk factors.

Key: FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, SBP = Systolic Blood Pressure, WCQR = Ways of Coping Questionnaire Revised; p = Level of statistical significance (p=<0.05 (in bold)), - = Not significant

Table 4.28 – Hierarchical multiple regression between pre-shift SBP and significantly correlated variables in police officers working a night shift (n=107)

Night Shift (n=107)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Pre-Shift SBP	0.59	0.35	0.25	10.72	**0.003**
	B	Std. Error	Beta	T	p
(Constant)	134.29	24.81		5.41	**<0.001**
Age	-0.10	0.19	-0.07	-0.54	0.60
Sex	-9.67	4.10	-0.33	-2.36	**0.022**
WHR	27.51	26.52	0.16	1.04	0.30
Lifestyle Risk Factors (LAQ Part 1)	0.36	0.25	0.19	1.43	0.16
Perception of Stress (LAQ Part 2)	-0.02	0.23	-0.02	-0.10	0.92
Sleep Disturbances (PSQIC5)	-0.17	3.31	-0.01	-0.05	0.96
Fatigue Severity (FSS)	-0.20	0.17	-0.19	-1.16	0.25
Escape-Avoidance (WCQR6)	-0.84	0.42	-0.25	-1.99	0.05

Table 4.28 shows hierarchical multiple regression analysis between pre-shift SBP and significant variables as determined by partial correlations; perceptions of stress (LAQ Part 2), frequency of sleep disturbances (PSQIC5), fatigue severity (FSS) and Escape-Avoidance prevalence (WCQR5). The model also accounts for the covariates of age, sex, WHR and lifestyle risk factors for the general duties police officers working a night shift (n=107).

Key: FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, SBP = Systolic Blood Pressure, WCQR = Ways of Coping Questionnaire Revised, WHR = Waist-Hip Ratio; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Post-shift SBP was found to share a number of similar negative relationships with pre-shift SBP when comparing between the shifts (Table 4.29). Again, there were no significant relationships identified with day-working officers' post-shift SBP. By comparison, officers working at night were found to have negatively correlations between post-shift SBP and perception of stress (r=-0.20, p=0.048), frequency of sleep disturbances (r=-0.29, p=0.003), fatigue severity (r=-0.34, p=0.009) and subjective fatigue (r=-0.27, p=0.048). A subsequent hierarchical multiple regression (Table 4.30) was performed using the significant correlations identified and was found to be overall significant for post-shift SBP (F(8,51) = 2.70, p=0.015). Together the independent variables explain 30% of the variance in night-shift working officers' post-shift SBP, with the covariates of sex (p=0.026) and lifestyle risk factors (p=0.039) being the significant predictors.

Table 4.29 – Significant partial correlations between independent variables and post-shift SBP for police officers working a day (n=148) or night shift (n=107)

Independent Variables	Post-Shift SBP			
	Day (n=148)		Night (n=107)	
	r	*p*	*r*	*p*
Perception of Stress (LAQ Part 2)	-	-	-0.20	**0.048**
Sleep Disturbances (PSQIC5)	-	-	-0.29	**0.003**
Fatigue Severity (FSS)	-	-	-0.34	**0.009**
Subjective Fatigue (CIS20-1)	-	-	-0.27	**0.048**

Table 4.29 shows significant results from partial Pearson's correlations between post-shift SBP and other independent variables for the police officers working a day (n=148) or night shift (n=107), accounting for the effects of age, sex, WHR and lifestyle risk factors.

Key: CIS20 = Checklist of Individual Strength, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, SBP = Systolic Blood Pressure; p = Level of statistical significance (p=<0.05 (in bold)), - = Not significant

Table 4.30 – Hierarchical multiple regression between post-shift SBP and significantly correlated variables in police officers working a night shift (n=107)

Night Shift (n=107)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Post-Shift SBP	0.55	0.30	0.19	11.25	**0.015**
	B	Std. Error	Beta	T	P
(Constant)	146.79	25.55		5.75	**<0.001**
Age	0.03	0.20	0.02	0.13	0.90
Sex	-10.54	4.60	-0.35	-2.29	**0.026**
WHR	0.30	28.07	0.00	0.01	0.99
Lifestyle Risk Factors (LAQ Part 1)	0.56	0.27	0.29	2.12	**0.039**
Perception of Stress (LAQ Part 2)	0.16	0.28	0.11	0.57	0.57
Sleep Disturbances (PSQIC5)	-2.79	3.68	-0.13	-0.76	0.45
Fatigue Severity (FSS)	-0.28	0.18	-0.26	-1.53	0.13
Subjective Fatigue (CIS20-1)	-0.10	0.26	-0.09	-0.40	0.69

Table 4.30 shows hierarchical multiple regression analysis between post-shift SBP and significant variables as determined by partial correlations; perceptions of stress (LAQ Part 2), frequency of sleep disturbances (PSQIC5), fatigue severity (FSS) and subjective fatigue (CIS20-1). The model also accounts for the covariates of age, sex, WHR and lifestyle risk factors for the general duties police officers working a night shift (n=107).

Key: CIS20 = Checklist of Individual Strength, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, SBP = Systolic Blood Pressure, WHR = Waist-Hip Ratio; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Finally, SBP reactivity (Table 4.31) was found to have only one significant association, where night-working officers' SBP reactivity was positively correlated with Distancing coping style prevalence (r=0.28, p=0.036). As such, no regressions were performed for day or night shift officers' SBP reactivity as there were less than three significant independent variables correlated for either shift.

Table 4.31 – Significant partial correlations between independent variables and SBP reactivity for police officers working a day (n=148) or night shift (n=107)

Independent Variables	SBP Reactivity			
	Day (n=148)		Night (n=107)	
	r	*p*	*r*	*p*
Distancing (WCQR2)	-	-	0.28	**0.036**

Table 4.31 shows significant results from partial Pearson's correlations between SBP reactivity and other independent variables for the police officers working a day (n=148) or night shift (n=107), accounting for the effects of age, sex, WHR and lifestyle risk factors.

Key: WCQR = Ways of Coping Questionnaire Revised; p = Level of statistical significance (p=<0.05 (in bold)), - = Not significant

Pre-shift DBP was found to have a number of significant relationships with other independent variables when comparing between shift, after accounting for the effects of age, sex, WHR and lifestyle risk factors (LAQ Part 1) (Table 4.32). While officers working the day shift were found to have no significant correlations, those working at night's pre-shift DBP was negatively correlated with perception of stress ($r=-0.24$, $p=0.014$), daytime dysfunction ($r=-0.23$, $p=0.020$), global PSQI score ($r=-0.26$, $p=0.007$) and fatigue severity ($r=-0.44$, $p=0.001$). A subsequent hierarchical multiple regression (Table 4.33) was performed using the significant correlations identified and was found to be overall significant for pre-shift DBP ($F(8,51) = 3.99$, $p=0.001$). Together the independent variables explain 39% of the variance in night-shift working officers' pre-shift DBP, with only the covariate of fatigue severity ($p=0.012$) being a significant predictor, while lifestyle risk factors was also trending towards significance ($p=0.05$).

Table 4.32 – Significant partial correlations between independent variables and pre-shift DBP for police officers working a day (n=148) or night shift (n=107)

Independent Variables	Pre-Shift DBP			
	Day (n=148)		Night (n=107)	
	r	*p*	*r*	*p*
Perception of Stress (LAQ Part 2)	-	-	-0.24	**0.014**
Daytime Dysfunction (PSQIC7)	-	-	-0.23	**0.020**
PSQI Global	-	-	-0.26	**0.007**
Fatigue Severity (FSS)	-	-	-0.44	**0.001**

Table 4.32 shows significant results from partial Pearson's correlations between pre-shift DBP and other independent variables for the police officers working a day (n=148) or night shift (n=107), accounting for the effects of age, sex, WHR and lifestyle risk factors.

Key: DBP = Diastolic Blood Pressure, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component; p = Level of statistical significance (p=<0.05 (in bold)), - = Not significant

Table 4.33 – Hierarchical multiple regression between pre-shift DBP and significantly correlated variables in police officers working a night shift (n=107)

Night Shift (n=107)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Pre-Shift DBP	0.62	0.39	0.29	7.85	**0.001**
	B	**Std. Error**	**Beta**	**T**	**p**
(Constant)	46.45	17.77		2.61	**0.012**
Age	0.22	0.13	0.21	1.69	0.10
Sex	3.41	3.01	0.15	1.14	0.26
WHR	30.25	19.39	0.23	1.56	0.13
Lifestyle Risk Factors (LAQ Part 1)	0.40	0.20	0.28	1.98	0.05
Perception of Stress (LAQ Part 2)	0.05	0.16	0.05	0.30	0.77
Daytime Dysfunction (PSQIC7)	0.53	1.66	0.05	0.32	0.75
PSQI Global	-0.06	0.39	-0.02	-0.14	0.89
Fatigue Severity (FSS)	-0.35	0.14	-0.44	-2.62	**0.012**

Table 4.33 shows hierarchical multiple regression analysis between pre-shift DBP and significant variables as determined by partial correlations; perceptions of stress (LAQ Part 2), daytime dysfunction (PSQIC7), global PSQI score and fatigue severity (FSS). The model also accounts for the covariates of age, sex, WHR and lifestyle risk factors for the general duties police officers working a night shift (n=107).

Key: DBP = Diastolic Blood Pressure, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, WHR = Waist-Hip Ratio; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Post-shift DBP was found to share a number of similar negative relationships with pre-shift DBP when comparing between the shifts (Table 4.34). Again, there were no significant relationships identified with day-working officers' post-shift DBP. By comparison, officers working at night were found to have negative correlations between post-shift DBP and perception of stress (r=-0.35, p<0.001), frequency of sleep disturbances (r=-0.27, p=0.006), sleep medication usage (r=-0.21, p=0.033), daytime dysfunction (r=-0.22, p=0.024), global PSQI score (r=-0.26, p=0.009), sleepiness risk (r=-0.20, p=0.045) and fatigue severity (r=-0.49, p<0.001). A subsequent hierarchical multiple regression (Table 4.35) was performed using the significant correlations identified and was found to be overall significant for post-shift DBP ($F(11,48) = 3.04$, p=0.004). Together the independent variables explain 41% of the variance in night-shift working officers' post-shift DBP, with lifestyle risk factors (p=0.015) and fatigue severity (p=0.018) being the significant predictors.

Table 4.34 – Significant partial correlations between independent variables and post-shift DBP for police officers working a day (n=148) or night shift (n=107)

Independent Variables	Post-Shift DBP			
	Day (n=148)		Night (n=107)	
	r	*p*	*r*	*p*
Perception of Stress (LAQ Part 2)	-	-	-0.35	**<0.001**
Sleep Disturbances (PSQIC5)	-	-	-0.27	**0.006**
Sleep Medication Usage (PSQIC6)	-	-	-0.21	**0.033**
Daytime Dysfunction (PSQIC7)	-	-	-0.22	**0.024**
PSQI Global	-	-	-0.26	**0.009**
Sleepiness Risk (ESS)	-	-	-0.20	**0.045**
Fatigue Severity (FSS)	-	-	-0.49	**<0.001**

Table 4.34 shows significant results from partial Pearson's correlations between post-shift DBP and other independent variables for the police officers working a day (n=148) or night shift (n=107), accounting for the effects of age, sex, WHR and lifestyle risk factors.

Key: DBP = Diastolic Blood Pressure, ESS = Epworth Sleepiness Scale, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component; p = Level of statistical significance (p=<0.05 (in bold)), - = Not significant

Table 4.35 – Hierarchical multiple regression between post-shift DBP and significantly correlated variables in police officers working a night shift (n=107)

Night Shift (n=107)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Post-Shift DBP	0.64	0.41	0.28	8.02	**0.004**
	B	**Std. Error**	**Beta**	**T**	**p**
(Constant)	58.83	18.56		3.17	**0.003**
Age	0.19	0.14	0.18	1.33	0.19
Sex	-0.98	3.10	-0.04	-0.32	0.75
WHR	21.58	20.10	0.16	1.07	0.29
Lifestyle Risk Factors (LAQ Part 1)	0.52	0.20	0.36	2.52	**0.015**
Perception of Stress (LAQ Part 2)	-0.12	0.18	-0.12	-0.71	0.48
Sleep Disturbances (PSQIC5)	0.58	2.62	0.04	0.22	0.83
Sleep Medication Usage (PSQIC6)	-1.12	1.71	-0.08	-0.65	0.52
Daytime Dysfunction (PSQIC7)	0.89	1.72	0.08	0.52	0.61
PSQI Global	0.12	0.44	0.05	0.27	0.79
Sleepiness Risk (ESS)	0.01	0.34	0.01	0.04	0.97
Fatigue Severity (FSS)	-0.36	0.15	-0.45	-2.46	**0.018**

Table 4.35 shows hierarchical multiple regression analysis between post-shift DBP and significant variables as determined by partial correlations; perceptions of stress (LAQ Part 2), frequency of sleep disturbances, sleep medication usage and daytime dysfunction (PSQI Components 5, 6 and 7 respectively), global PSQI score, sleepiness risk (ESS) and fatigue severity (FSS). The model also accounts for the covariates of age, sex, WHR and lifestyle risk factors for the general duties police officers working a night shift (n=107).

Key: DBP = Diastolic Blood Pressure, Epworth Sleepiness Scale, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, WHR = Waist-Hip Ratio; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Finally, DBP reactivity (Table 4.36) was found to have only one significant association, where day-working officers' DBP reactivity was negatively correlated with TTW (r=-0.25, p=0.018). As such, no regressions were performed for day or night shift officers' DBP reactivity as there were less than three significant independent variables correlated for either shift.

Table 4.36 – Significant partial correlations between independent variables and DBP reactivity for police officers working a day (n=148) or night shift (n=107)

Independent Variables	DBP Reactivity			
	Day (n=148)		Night (n=107)	
	r	p	r	p
TTW	-0.25	**0.018**	-	-

Table 4.36 shows significant results from partial Pearson's correlations between DBP reactivity and other independent variables for the police officers working a day (n=148) or night shift (n=107), accounting for the effects of age, sex, WHR and lifestyle risk factors.

Key: DBP = Diastolic Blood Pressure, TTW = Total Travel Work Time; p = Level of statistical significance (p=<0.05 (in bold)), - = Not significant

4.1.4 Results: Blood Pressure and Shift work (rank comparison)

This section presents the results in the context of comparing the general duties police officers based on their rank; 57 were probationary constables (PC) (<1 year service), 99 were constables (C), 53 were senior constables (SC) and 46 were sergeants (Sgt) comprising the total sample (N=255). Their demographics, BP, associated correlations and regression analyses follow.

4.1.4.1 Demographics (rank comparison)

Mean (± SD) demographics for PC (n=57), C (n=99), SC (n=53) and Sgt (n=46) are provided in Table 4.37. Analysis of Variance (ANOVA) was performed to determine whether the demographic means recorded differed between ranks (Table 4.38), with a Tukey post-hoc used to identify where the differences lay if statistically significant. Age was found to differ significantly between ranks ($p<0.001$), with SC being found to be significantly older than PC ($p<0.001$) and C ($p<0.001$), and Sgt identified as being much older than PC ($p<0.001$), C ($p<0.001$) and SC ($p<0.001$). Although all PC's were recorded as serving <1 year, years of service was also found to significantly differ between ranks ($p<0.001$). Expectedly, Sgt had served significantly longer than PC ($p<0.001$), C ($p<0.001$) and SC ($p<0.001$), while SC had served longer than PC ($p<0.001$) and C ($p<0.001$), with C also serving longer than PC ($p<0.001$).

WHR was found to significantly differ between officer based on rank ($p<0.001$), with Sgt being significantly larger than PC ($p<0.001$) and C ($p<0.001$), while this difference was trending towards significance with SC ($p=0.05$). Finally, lifestyle risk factors was also found to differ significantly between ranks ($p=0.007$), with Sgt having a higher mean score than PC ($p=0.010$) and C ($p=0.009$). TTW was not found to significantly differ between police officers based on rank after performing an ANOVA.

Table 4.37 – Mean demographic values for probationary constables (n=57), constables (n=99), senior constables (n=53) and sergeants (n=46)

Demographics	PC (n=57)	C (n=99)	SC (n=53)	Sgt (n=46)
Years of Age	25.67 ± 4.47	27.46 ± 4.92	35.23 ± 7.40	42.04 ± 8.19
Years of Service	n/a	2.51 ± 1.13	9.43 ± 3.71	19.64 ± 7.07
WHR	0.83 ± 0.06	0.84 ± 0.07	0.86 ± 0.09	0.89 ± 0.06
TTW	306.05 ± 197.00	345.74 ± 274.11	336.30 ± 253.82	241.79 ± 140.45
Lifestyle Risk Factors (LAQ Part 1)	11.96 ± 5.37	12.29 ± 5.45	13.17 ± 6.34	15.61 ± 6.57

Table 4.37 shows mean demographic scores (presented as mean ± SD) for the PC, C, SC and Sgt (n=7, n=99, n=53 and n=46 respectively). Due to all PC's being <1 year service, no mean could be determined. Total travel work time (TTW) was calculated by averaging the hours required to travel to and from work across the course of the average week. The maximum score for the LAQ Part 1 (lifestyle risk factors) is 70, with greater scores indicating an increased likelihood of developing a chronic illness.

Key: C = Constable, LAQ = Lifestyle Appraisal Questionnaire, PC = Probationary Constable, SC = Senior Constable, Sgt = Sergeant, TTW = Total Travel Work Time, WHR = Waist-Hip Ratio; n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), SD = Standard Deviation, ± = Plus and minus, - = Not significant

Table 4.38 – Significant differences in demographics variables for probationary constables (n=57), constables (n=99), senior constables (n=53) and sergeants (n=46)

Variable	p (ANOVA)	Location of difference	p (Tukey HSD test)
Years of Age	**<0.001**	1 (PC) vs. 3 (SC)	**<0.001**
		1 vs. 4 (Sgt)	**<0.001**
		2 (C) vs. 3	**<0.001**
		2 vs. 4	**<0.001**
		3 vs. 4	**<0.001**
Years of Service	**<0.001**	1 vs. 2	**0.004**
		1 vs. 3	**<0.001**
		1 vs. 4	**<0.001**
		2 vs. 3	**<0.001**
		2 vs. 4	**<0.001**
		3 vs. 4	**<0.001**
WHR	**<0.001**	1 vs. 4	**<0.001**
		2 vs. 4	**<0.001**
		3 vs. 4	0.050
TTW	-	-	-
Lifestyle Risk Factors (LAQ Part 1)	**0.007**	1 vs. 4	**0.010**
		2 vs. 4	**0.009**

Table 4.38 summarises significant differences between the general duties police officers based on their rank. ANOVA was used and where significant a Tukey HSD post-hoc was performed to identify the location of the differences. Age, years of service and WHR were all found to significantly differ between PC (n=57), C (n=99), SC (n=53) and Sgt (n=46).

Key: ANOVA = Analysis of Variance, C = Constable, HSD = Honestly Significant Difference, LAQ = Lifestyle Appraisal Questionnaire, PC = Probationary Constable, SC = Senior Constable, Sgt = Sergeant, WHR = Waist-Hip Ratio; n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), - = Not significant

4.1.4.2 Blood Pressure (rank comparison)

Mean (± SD) BP values for PC (n=57), C (n=99), SC (n=53) and Sgt (n=46) are provided in Table 4.39. Paired sample t-tests found only SC SBP significantly increased from pre to post-shift ($p<0.050$). Multivariate Analysis of Covariance (MANCOVA) was also performed to determine whether the cardiac means recorded differed between ranks after accounting for the covariates of age, sex, WHR and lifestyle risk factors (LAQ Part 1), detailed in Section 4.1.1.3 (Table 4.40). Pre-shift SBP was found to significantly differ between the ranks ($p<0.001$), with a Tukey post-hoc analysis identifying Sgt's mean pre-shift SBP as higher than PC ($p=0.040$), C ($p<0.001$) and SC ($p<0.001$). Similarly, post-shift SBP also different significantly between officers based on rank ($p<0.001$), with Sgt's mean post-shift SBP found to be higher than C (<.001) and SC ($p=0.002$), while PC was higher than C too ($p=0.042$). SBP reactivity was not found to significantly differ between police officers based on rank after performing an MANCOVA.

Pre-shift DBP was found to significantly differ between the ranks ($p<0.001$), with Sgt having a higher mean than C ($p=0.015$) and SC ($p=0.014$). Similarly, post-shift also differed significantly ($p<0.001$), as Sgt average post-shift DBP was again found to be higher than C ($p=0.001$) and SC ($p=0.030$). Finally, DBP reactivity was also found to differ between the ranks after performing MANCOVA ($p=0.029$), however only PC mean DBP reactivity was larger than C ($p=0.005$).

Table 4.39 – Mean cardiac values for probationary constables (n=57), constables (n=99), senior constables (n=53) and sergeants (n=46)

Rank	Cardiac Value (mmHg)	Pre-Shift	Post-Shift	Reactivity
PC	SBP	128.89 ± 12.65	130.05 ± 11.57	1.16 ± 7.95
	DBP	74.19 ± 8.08	75.49 ± 8.03	1.30 ± 6.37
C	SBP	126.97 ± 11.89	127.80 ± 11.81	0.83 ± 8.10
	DBP	75.89 ± 8.16	75.20 ± 8.58	-0.69 ± 5.86
SC	SBP	123.60 ± 12.37	125.81 ± 11.90	2.21 ± 7.82*
	DBP	76.19 ± 9.33	76.13 ± 9.55	-0.06 ± 6.56
Sgt	SBP	132.57 ± 12.06	133.41 ± 13.53	0.85 ± 8.91
	DBP	82.07 ± 8.19	81.85 ± 9.45	-0.22 ± 5.66

Table 4.39 shows mean cardiac values for the PC, C, SC and Sgt (n=7, n=99, n=53 and n=46 respectively). BP was taken before and after the subjects' regular shift, with reactivity calculated by deducting the pre-shift from the post-shift result. Dependant sample t-tests were performed and only SC's SBP was found to be significantly greater after shift.

Key: C = Constable, DBP = Diastolic Blood Pressure, PC = Probationary Constable, SBP = Systolic Blood Pressure, SC = Senior Constable, Sgt = Sergeant; mmHg = Millimetres of mercury, n=Sample size, SD = Standard Deviation, ± = Plus and minus, * = Significant independent t-test result ($p<0.05$)

Table 4.40 – Significant differences in cardiac variables for probationary constables (n=57), constables (n=99), senior constables (n=53) and sergeants (n=46)

Variable	p (MANCOVA)	Location of difference	p (Tukey HSD test)
Pre-Shift SBP	**<0.001**	1 (PC) vs. 4 (Sgt)	**0.040**
		2 (C) vs. 4	**<0.001**
		3 (SC) vs. 4	**<0.001**
Post-Shift SBP	**<0.001**	1 vs. 2	**0.042**
		2 vs. 4	**<0.001**
		3 vs. 4	**0.002**
SBP Reactivity	-	-	-
Pre-Shift DBP	**<0.001**	2 vs. 4	**0.015**
		3 vs. 4	**0.014**
Post-Shift DBP	**<0.001**	2 vs. 4	**0.001**
		3 vs. 4	**0.030**
DBP Reactivity	**0.029**	1 vs. 2	**0.005**

Table 4.40 summarises significant differences between the general duties police officers based on their rank. MANCOVA, accounting for age, sex, WHR and lifestyle risk factors (LAQ Part 1), was used and where significant a Tukey HSD post-hoc was performed to identify the location of the differences. All cardiac values, except for SBP reactivity, were found to significantly differ between PC (n=57), C (n=99), SC (n=53) and Sgt (n=46).

Key: DBP = Diastolic Blood Pressure, C = Constable, HSD = Honestly Significant Difference, LAQ = Lifestyle Appraisal Questionnaire, MANCOVA = Multivariate Analysis of Covariance, PC = Probationary Constable, SBP = Systolic Blood Pressure, SC = Senior Constable, Sgt = Sergeant, WHR = Waist-Hip Ratio; n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), - = Not significant

4.1.4.3 Blood Pressure Associations & Regression Analyses (rank comparison)

Partial correlations were performed to identify the relationship between police officers' BP and other independent variables depending on their rank. The covariates accounted for were age, sex, WHR and lifestyle risk factors (LAQ Part 1), detailed in Section 4.1.1.3. Where three or more independent variables were found to be significantly correlated with the dependant variable of BP, consequent hierarchical multiple regressions were performed.

Pre-shift SBP was found to have a number of significant relationships with other independent variables when comparing between the ranks, after accounting for the effects of age, sex, WHR and lifestyle risk factors (LAQ Part 1) (Table 4.41). PC pre-shift SBP was negatively associated with sleep duration ($r=-0.29$, $p=0.036$), while Sgt had a positive relationship with Positive Reappraisal coping style prevalence ($r=0.46$, $p=0.021$) and no correlations were found with SC pre-shift SBP. As such, no regressions were performed for PC, SC or Sgt ranked officers' pre-shift SBP as there were less than three significant independent variables correlated for the ranks.

By comparison, C pre-shift SBP was negatively correlated with perception of stress ($r=-0.31$, $p=0.003$), daytime dysfunction ($r=-0.24$, $p=0.018$) and Escape-Avoidance coping style prevalence ($r=-0.29$, $p=0.034$). A subsequent hierarchical multiple regression (Table 4.42) was performed using the significant correlations identified and was found to be overall significant for pre-shift SBP ($F(7,54) = 6.25$, $p<0.001$). Together the independent variables explain 45% of the variance in C ranked officers' pre-shift SBP, with only the covariate of sex ($p<0.001$) being a significant predictor.

Table 4.41 – Significant partial correlations between independent variables and pre-shift SBP for probationary constables (n=57), constables (n=99), senior constables (n=53) and sergeants (n=46)

Independent Variables	Pre-Shift SBP							
	PC		C		SC		Sgt	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*
Perception of Stress (LAQ Part 2)	-	-	-0.31	**0.003**	-	-	-	-
Sleep Duration (PSQIC3)	-0.29	**0.036**	-	-	-	-	-	-
Daytime Dysfunction (PSQIC7)	-	-	-0.24	**0.018**	-	-	-	-
Escape-Avoidance (WCQR6)	-	-	-0.29	**0.034**	-	-	-	-
Positive Reappraisal (WCQR8)	-	-	-	-	-	-	0.46	**0.021**

Table 4.41 shows significant results from partial Pearson's correlations between pre-shift SBP and other independent variables for the PC, C, SC and Sgt (n=7, n=99, n=53 and n=46 respectively), accounting for the effects of age, sex, WHR and lifestyle risk factors.

Key: LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, SBP = Systolic Blood Pressure, WCQR = Ways of Coping Questionnaire Revised; p = Level of statistical significance (p=<0.05 (in bold)), - = Not significant

Table 4.42 – Hierarchical multiple regression between pre-shift SBP and significantly correlated variables in constables (n=99)

Constables (n=99)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Pre-Shift SBP	0.67	0.45	0.38	9.39	**<0.001**
	B	**Std. Error**	**Beta**	**T**	**p**
(Constant)	166.10	19.59		8.48	**<0.001**
Age	-0.36	0.26	-0.15	-1.39	0.17
Sex	-13.88	3.02	-0.57	-4.59	**<0.001**
WHR	-4.43	20.82	-0.03	-0.21	0.83
Lifestyle Risk Factors (LAQ Part 1)	0.37	0.24	0.17	1.52	0.14
Perception of Stress (LAQ Part 2)	-0.15	0.15	-0.13	-1.00	0.32
Daytime Dysfunction (PSQIC7)	-2.42	1.66	-0.17	-1.45	0.15
Escape-Avoidance (WCQR6)	-0.42	0.28	-0.18	-1.54	0.13

Table 4.42 shows hierarchical multiple regression analysis between pre-shift SBP and significant variables as determined by partial correlations; perceptions of stress (LAQ Part 2), sleep duration and daytime dysfunction (PSQI Components 3 and 7 respectively), as well as Escape-Avoidance prevalence (WCQR6). The model also accounts for the covariates of age, sex, WHR and lifestyle risk factors for the constables (n=99).

Key: LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, SBP = Systolic Blood Pressure, WCQR = Ways of Coping Questionnaire Revised, WHR = Waist-Hip Ratio; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Post-shift SBP was found to share a number of similar negative relationships with pre-shift SBP when comparing between the ranks (Table 4.43). PC pre-shift SBP was negatively associated with global PSQI score ($r=-0.30$, $p=0.033$), while SC had a negative relationship with fatigue severity ($r=-0.43$, $p=0.034$) and only subjective fatigue was found to negatively correlate with Sgt pre-shift SBP ($r=-0.44$, $p=0.027$). As such, no regressions were performed for PC, SC or Sgt ranked officers' post-shift SBP as there were less than three significant independent variables correlated for the ranks.

By comparison, C post-shift SBP was negatively correlated with perception of stress ($r=-0.21$, $p=0.038$), subjective sleep quality ($r=-0.20$, $p=0.049$), daytime dysfunction ($r=-0.31$, $p=0.003$), global PSQI score ($r=-0.21$, $p=0.045$) and fatigue severity ($r=-0.26$, $p=0.048$). A subsequent hierarchical multiple regression (Table 4.44) was performed using the significant correlations identified and was found to be overall significant for post-shift SBP ($F(9,52) = 3.46$, $p=0.002$). Together the independent variables explain 37% of the variance in C ranked officers' post-shift SBP, with only the covariate of sex ($p<0.001$) being a significant predictor.

Table 4.43 – Significant partial correlations between independent variables and post-shift SBP for probationary constables (n=57), constables (n=99), senior constables (n=53) and sergeants (n=46)

Independent Variables	Post-Shift SBP							
	PC		C		SC		Sgt	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*
Perception of Stress (LAQ Part 2)	-	-	-0.21	**0.038**	-	-	-	-
Subjective Sleep Quality (PSQIC1)	-	-	-0.20	**0.049**	-	-	-	-
Daytime Dysfunction (PSQIC7)	-	-	-0.31	**0.003**	-	-	-	-
PSQI Global	-0.30	**0.033**	-0.21	**0.045**	-	-	-	-
Fatigue Severity (FSS)	-	-	-0.26	**0.048**	-0.43	**0.034**	-	-
Subjective Fatigue (CIS20-1)	-	-	-	-	-	-	-0.44	**0.027**

Table 4.43 shows significant results from partial Pearson's correlations between post-shift SBP and other independent variables for the PC, C, SC and Sgt (n=7, n=99, n=53 and n=46 respectively), accounting for the effects of age, sex, WHR and lifestyle risk factors.

Key: CIS20 = Checklist of Individual Strength, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, SBP = Systolic Blood Pressure; p = Level of statistical significance (p=<0.05 (in bold)), - = Not significant

Table 4.44 – Hierarchical multiple regression between post-shift SBP and significantly correlated variables in constables (n=99)

Constables (n=99)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Post-Shift SBP	0.61	0.37	0.27	10.11	**0.002**
	B	**Std. Error**	**Beta**	**T**	**p**
(Constant)	184.38	20.81		8.86	**<0.001**
Age	-0.37	0.28	-0.16	-1.32	0.19
Sex	-13.05	3.34	-0.54	-3.91	**<0.001**
WHR	-28.72	22.62	-0.18	-1.27	0.21
Lifestyle Risk Factors (LAQ Part 1)	0.28	0.27	0.13	1.02	0.31
Perception of Stress (LAQ Part 2)	-0.10	0.16	-0.09	-0.62	0.54
Subjective Sleep Quality (PSQIC1)	-0.79	2.64	-0.05	-0.30	0.77
Daytime Dysfunction (PSQIC7)	-2.97	2.17	-0.21	-1.37	0.18
PSQI Global	0.09	0.64	0.03	0.15	0.88
Fatigue Severity (FSS)	-0.07	0.19	-0.06	-0.39	0.70

Table 4.44 shows hierarchical multiple regression analysis between post-shift SBP and significant variables as determined by partial correlations; perceptions of stress (LAQ Part 2), subjective sleep quality and daytime dysfunction (PSQI Components 1 and 7 respectively), global PSQI score and fatigue severity (FSS). The model also accounts for the covariates of age, sex, WHR and lifestyle risk factors for the constables (n=99).

Key: FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, SBP = Systolic Blood Pressure, WHR = Waist-Hip Ratio; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Finally, SBP reactivity (Table 4.45) was found to have a few significant associations, however none were identified for the PC, SC or Sgt ranked officers. Only C SBP reactivity was found to be negatively correlated with subjective sleep quality ($r=-0.23$, $p=0.023$) and global PSQI score ($r=-0.24$, $p=0.020$), and positively associated with Confrontive Coping ($r=0.30$, $p=0.022$), Self-Controlling ($r=0.26$, $p=0.049$) and Escape-Avoidance coping style prevalent ($r=0.28$, $p=0.034$). A subsequent hierarchical multiple regression (Table 4.46) was performed and found to not be significant ($F(9,52) = 1.55$, $p=0.15$). Together the independent variables explain 21% of the variance in C ranked SBP reactivity, although none were found to contribute significantly to the collective prediction.

Table 4.45 – Significant partial correlations between independent variables and SBP reactivity for probationary constables (n=57), constables (n=99), senior constables (n=53) and sergeants (n=46)

Independent Variables	SBP Reactivity							
	PC		C		SC		Sgt	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*
Subjective Sleep Quality (PSQIC1)	-	-	-0.23	**0.023**	-	-	-	-
PSQI Global	-	-	-0.24	**0.020**	-	-	-	-
Confrontive Coping (WCQR1)	-	-	0.30	**0.022**	-	-	-	-
Self-Controlling (WCQR3)	-	-	0.26	**0.049**	-	-	-	-
Escape-Avoidance (WCQR6)	-	-	0.28	**0.034**	-	-	-	-

Table 4.45 shows significant results from partial Pearson's correlations between SBP reactivity and other independent variables for the PC, C, SC and Sgt (n=7, n=99, n=53 and n=46 respectively), accounting for the effects of age, sex, WHR and lifestyle risk factors.

Key: PSQIC = Pittsburgh Sleep Quality Index Component, SBP = Systolic Blood Pressure, WCQR = Ways of Coping Questionnaire Revised; p = Level of statistical significance (p=<0.05 (in bold)), - = Not significant

Table 4.46 – Hierarchical multiple regression between SBP reactivity and significantly correlated variables in constables (n=99)

Constables (n=99)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
SBP Reactivity	0.46	0.21	0.08	7.79	0.15
	B	Std. Error	Beta	T	P
(Constant)	14.41	16.45		0.88	0.39
Age	0.01	0.22	0.00	0.03	0.97
Sex	0.84	2.51	0.05	0.34	0.74
WHR	-24.05	17.20	-0.21	-1.40	0.17
Lifestyle Risk Factors (LAQ Part 1)	-0.02	0.21	-0.01	-0.09	0.93
Subjective Sleep Quality (PSQIC1)	-2.23	2.00	-0.22	-1.12	0.27
PSQI Global	-0.05	0.47	-0.02	-0.10	0.92
Confrontive Coping (WCQR1)	0.38	0.39	0.17	0.98	0.33
Self-Controlling (WCQR3)	0.00	0.37	0.00	0.00	0.99
Escape-Avoidance (WCQR6)	0.31	0.27	0.19	1.13	0.26

Table 4.46 shows hierarchical multiple regression analysis between SBP reactivity and significant variables as determined by partial correlations; subjective sleep quality (PSQIC1) and global PSQI score, as well as Confrontive Coping, Self-Controlling and Escape-Avoidance prevalence (WCQR 1, 3 and 6 respectively). The model also accounts for the covariates of age, sex, WHR and lifestyle risk factors for the constables (n=99).

Key: LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, SBP = Systolic Blood Pressure, WCQR = Ways of Coping Questionnaire Revised, WHR = Waist-Hip Ratio; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Pre-shift DBP was found to have a number of significant relationships with other independent variables when comparing between the ranks, after accounting for the effects of age, sex, WHR and lifestyle risk factors (LAQ Part 1) (Table 4.47). PC pre-shift DBP was negatively associated with Accepting Responsibility coping style prevalence ($r=-0.35$, $p=0.038$), while SC had a negative relationship with sleep duration ($r=-0.36$, $p=0.012$) and fatigue severity ($r=-0.46$, $p=0.025$), and only Positive Reappraisal coping style prevalence was found to positively correlate with Sgt pre-shift DBP ($r=0.49$, $p=0.013$). As such, no regressions were performed for PC, SC or Sgt ranked officers' post-shift SBP as there were less than three significant independent variables correlated for the ranks.

By comparison, C pre-shift DBP was negatively correlated with perception of stress ($r=-0.38$, $p<0.001$), sleep medication usage ($r=-0.23$, $p=0.023$), daytime dysfunction ($r=-0.30$, $p=0.003$), fatigue severity ($r=-0.33$, $p=0.011$), Seeking Social Support ($r=-0.34$, $p=0.010$) and Escape-Avoidance coping style prevalence ($r=-0.30$, $p=0.022$), as well as reduced concentration ($r=-0.30$, $p=0.020$). A subsequent hierarchical multiple regression (Table 4.48) was performed using the significant correlations identified and was found to be overall significant for pre-shift DBP ($F(11,50) = 3.05$, $p=0.003$). Together the independent variables explain 40% of the variance in C ranked officers' pre-shift DBP, with lifestyle risk factors ($p=0.001$) and Seeking Social Support coping style prevalence ($p=0.049$) being the significant predictors.

Table 4.47 – Significant partial correlations between independent variables and pre-shift DBP for probationary constables (n=57), constables (n=99), senior constables (n=53) and sergeants (n=46)

Independent Variables	Pre-Shift DBP							
	PC		C		SC		Sgt	
	r	*p*	*r*	*P*	*r*	*p*	*r*	*p*
Perception of Stress (LAQ Part 2)	-	-	-0.38	**<0.001**	-	-	-	-
Sleep Duration (PSQIC3)	-	-	-	-	-0.36	**0.012**	-	-
Sleep Medication Usage (PSQIC6)	-	-	-0.23	**0.023**	-	-	-	-
Daytime Dysfunction (PSQIC7)	-	-	-0.30	**0.003**	-	-	-	-
Fatigue Severity (FSS)	-	-	-0.33	**0.011**	-0.46	**0.025**	-	-
Seeking Social Support (WCQR4)	-	-	-0.34	**0.010**	-	-	-	-
Accepting Responsibility (WCQR5)	-0.35	**0.038**	-	-	-	-	-	-
Escape-Avoidance (WCQR6)	-	-	-0.30	**0.022**	-	-	-	-
Positive Reappraisal (WCQR8)	-	-	-	-	-	-	0.49	**0.013**
Reduced Concentration (CIS20-2)	-	-	-0.30	**0.020**	-	-	-	-

Table 4.47 shows significant results from partial Pearson's correlations between pre-shift DBP and other independent variables for the PC, C, SC and Sgt (n=7, n=99, n=53 and n=46 respectively), accounting for the effects of age, sex, WHR and lifestyle risk factors.

Key: CIS20 = Checklist of Individual Strength, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, SBP = Systolic Blood Pressure, WCQR = Ways of Coping Questionnaire Revised; p = Level of statistical significance (p=<0.05 (in bold)), - = Not significant

Table 4.48 – Hierarchical multiple regression between pre-shift DBP and significantly correlated variables in constables (n=99)

Constables (n=99)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Pre-Shift DBP	0.63	0.40	0.27	6.97	**0.003**
	B	**Std. Error**	**Beta**	**T**	**p**
(Constant)	78.53	16.33		4.81	**<0.001**
Age	0.28	0.19	0.17	1.46	0.15
Sex	-0.85	2.41	-0.05	-0.35	0.73
WHR	2.20	16.12	0.02	0.14	0.89
Lifestyle Risk Factors (LAQ Part 1)	0.66	0.20	0.44	3.36	**0.001**
Perception of Stress (LAQ Part 2)	-0.69	1.26	-0.08	-0.55	0.58
Sleep Medication Usage (PSQIC6)	-1.59	1.66	-0.13	-0.96	0.34
Daytime Dysfunction (PSQIC7)	-1.45	1.45	-0.15	-1.01	0.32
Fatigue Severity (FSS)	-0.10	0.14	-0.13	-0.74	0.46
Seeking Social Support (WCQR4)	-0.58	0.29	-0.27	-2.02	**0.049**
Escape-Avoidance (WCQR6)	-0.23	0.22	-0.15	-1.06	0.29
Reduced Concentration (CIS20-2)	-0.10	0.22	-0.07	-0.44	0.66

Table 4.48 shows hierarchical multiple regression analysis between pre-shift DBP and significant variables as determined by partial correlations; subjective sleep quality (PSQIC1) and global PSQI score, as well as Confrontive Coping, Self-Controlling and Escape-Avoidance prevalence (WCQR 1, 3 and 6 respectively). The model also accounts for the covariates of age, sex, WHR and lifestyle risk factors for the constables (n=99).

Key: DBP = Diastolic Blood Pressure, CIS20 = Checklist of Individual Strength, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, WCQR = Ways of Coping Questionnaire Revised, WHR = Waist-Hip Ratio; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Post-shift DBP was found to share a number of similar significant relationships with pre-shift DBP when comparing between the ranks (Table 4.49). PC pre-shift SBP was only positively associated with Planful Problem-Solving coping style prevalence ($r=0.38$, $p=0.026$), while no significant correlations were identified for Sgt post-shift DBP. As such, no regressions were performed for PC or Sgt ranked officers' post-shift DBP as there were less than three significant independent variables correlated for the ranks.

By comparison, C post-shift DBP was negatively correlated with perception of stress ($r=-0.30$, $p=0.003$), subjective sleep quality ($r=-0.21$, $p=0.041$), frequency of sleep disturbances ($r=-0.27$, $p=0.009$), sleep medication usage ($r=-0.29$, $p=0.005$), daytime dysfunction ($r=-0.40$, $p<0.001$), global PSQI score ($r=-0.32$, $p=0.002$), sleepiness risk ($r=-0.21$, $p=0.042$), fatigue severity ($r=-0.36$, $p=0.005$) and Seeking Social Support coping style prevalence ($r=-0.28$, $p=0.031$). A subsequent hierarchical multiple regression (Table 4.50) was performed using the significant correlations identified and was found to be overall significant for post-shift DBP ($F(13,48) = 2.19$, $p=0.025$). Together the independent variables explain 37% of the variance in C ranked officers' post-shift DBP, with lifestyle risk factors ($p=0.028$) and Seeking Social Support coping style prevalence ($p=0.037$) being the significant predictors.

Further, SC post-shift DBP was negatively associated with sleep duration ($r=-0.32$, $p=0.026$), global PSQI score ($r=-0.30$, $p=0.039$), sleepiness risk ($r=-0.28$, $p=0.048$) and fatigue severity ($r=-0.46$, $p=0.024$). A subsequent hierarchical multiple regression (Table 4.51) was performed and found to not be significant ($F(8,19) = 1.83$, $p=0.13$). Together the independent variables explain 44% of the variance in SC ranked officers' post-shift SBP, with only the covariate of fatigue severity being a predictor which was trending towards significance ($p=0.07$).

Table 4.49 – Significant partial correlations between independent variables and post-shift DBP for probationary constables (n=57), constables (n=99), senior constables (n=53) and sergeants (n=46)

Independent Variables	Post-Shift DBP							
	PC		C		SC		Sgt	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*
Perception of Stress (LAQ Part 2)	-	-	-0.30	**0.003**	-	-	-	-
Subjective Sleep Quality (PSQIC1)	-	-	-0.21	**0.041**	-	-	-	-
Sleep Duration (PSQIC3)	-	-	-	-	-0.32	**0.026**	-	-
Sleep Disturbances (PSQIC5)	-	-	-0.27	**0.009**	-	-	-	-
Sleep Medication Usage (PSQIC6)	-	-	-0.29	**0.005**	-	-	-	-
Daytime Dysfunction (PSQIC7)	-	-	-0.40	**<0.001**	-	-	-	-
PSQI Global	-	-	-0.32	**0.002**	-0.30	**0.039**	-	-
Sleepiness Risk (ESS)	-	-	-0.21	**0.042**	-0.28	**0.048**	-	-
Fatigue Severity (FSS)	-	-	-0.36	**0.005**	-0.46	**0.024**	-	-
Seeking Social Support (WCQR4)	-	-	-0.28	**0.031**	-	-	-	-
Planful Problem-Solving (WCQR7)	0.38	**0.026**	-	-	-	-	-	-

Table 4.49 shows significant results from partial Pearson's correlations between post-shift DBP and other independent variables for the PC, C, SC and Sgt (n=7, n=99, n=53 and n=46 respectively), accounting for the effects of age, sex, WHR and lifestyle risk factors.

Key: DBP = Diastolic Blood Pressure, ESS = Epworth Sleepiness Scale, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, WCQR = Ways of Coping Questionnaire Revised; p = Level of statistical significance (p=<0.05 (in bold)), - = Not significant

Table 4.50 – Hierarchical multiple regression between post-shift DBP and significantly correlated variables in constables (n=99)

Constables (n=99)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Post-Shift DBP	0.61	0.37	0.20	7.66	**0.025**
	B	**Std. Error**	**Beta**	**T**	**p**
(Constant)	87.93	17.69		4.97	**<0.001**
Age	0.27	0.22	0.16	1.26	0.21
Sex	-1.06	2.61	-0.06	-0.41	0.69
WHR	-7.16	17.81	-0.06	-0.40	0.69
Lifestyle Risk Factors (LAQ Part 1)	0.49	0.21	0.31	2.26	**0.028**
Perception of Stress (LAQ Part 2)	-0.11	0.12	-0.14	-0.94	0.35
Subjective Sleep Quality (PSQIC1)	1.83	2.13	0.17	0.86	0.39
Sleep Disturbances (PSQIC5)	-1.83	2.40	-0.12	-0.76	0.45
Sleep Medication Usage (PSQIC6)	-1.55	1.91	-0.12	-0.81	0.42
Daytime Dysfunction (PSQIC7)	-2.38	1.69	-0.23	-1.41	0.16
PSQI Global	-0.28	0.55	-0.12	-0.52	0.61
Sleepiness Risk (ESS)	-0.01	0.32	-0.01	-0.04	0.97
Fatigue Severity (FSS)	-0.11	0.15	-0.13	-0.73	0.47
Seeking Social Support (WCQR4)	-0.59	0.27	-0.26	-2.15	**0.037**

Table 4.50 shows hierarchical multiple regression analysis between post-shift DBP and significant variables as determined by partial correlations; perceptions of stress (LAQ Part 2), subjective sleep quality, frequency of sleep disturbances, sleep medication usage and daytime dysfunction (PSQI Components 1, 5, 6 and 7 respectively), global PSQI score, sleepiness risk (ESS) and fatigue severity (FSS), as well as Seeking Social Support prevalence (WCQR4). The model also accounts for the covariates of age, sex, WHR and lifestyle risk factors for the constables (n=99).

Key: DBP = Diastolic Blood Pressure, ESS = Epworth Sleepiness Scale, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, WCQR = Ways of Coping Questionnaire Revised, WHR = Waist-Hip Ratio; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Table 4.51 – Hierarchical multiple regression between post-shift DBP and significantly correlated variables in senior constables (n=53)

Senior Constables (n=53)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Post-Shift DBP	0.66	0.44	0.20	8.56	0.13
	B	**Std. Error**	**Beta**	**T**	**p**
(Constant)	86.23	27.66		3.12	**0.006**
Age	0.12	0.26	0.10	0.47	0.64
Sex	-4.15	4.28	-0.21	-0.97	0.34
WHR	0.67	25.21	0.01	0.03	0.98
Lifestyle Risk Factors (LAQ Part 1)	0.57	0.33	0.38	1.74	0.10
Sleep Duration (PSQIC3)	-3.01	2.65	-0.27	-1.13	0.27
PSQI Global	0.46	0.80	0.17	0.58	0.57
Sleepiness Risk (ESS)	-0.41	0.46	-0.19	-0.90	0.38
Fatigue Severity (FSS)	-0.40	0.21	-0.41	-1.90	0.07

Table 4.51 shows hierarchical multiple regression analysis between post-shift DBP and significant variables as determined by partial correlations; sleep duration (PSQIC3), global PSQI score, sleepiness risk (ESS) and fatigue severity (FSS). The model also accounts for the covariates of age, sex, WHR and lifestyle risk factors for the senior constables (n=53).

Key: DBP = Diastolic Blood Pressure, ESS = Epworth Sleepiness Scale, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, WHR = Waist-Hip Ratio; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Finally, DBP reactivity (Table 4.52) was found to have a number of significant associations when comparing between the ranks. C DBP reactivity was positively associated with Self-Controlling (r=0.32, p=0.013) and Escape-Avoidance coping style prevalence (r=0.36, p=0.006), while sleep onset latency (r=-0.37, p=0.015) and frequency of sleep disturbances (r=-0.36, p=0.019) were negatively correlated with Sgt DBP reactivity. As such, no regressions were performed for C or Sgt ranked officers' DBP reactivity as there were less than three significant independent variables correlated for the ranks.

By comparison, PC DBP reactivity was negatively correlated with TTW (r=-0.54, p=0.001), and positively associated with Distancing (r=0.38, p=0.024), Seeking Social Support (r=0.34, p=0.046), Accepting Responsibility (r=0.40, p=0.019), Planful Problem-Solving (r=0.42, p =.012) and Positive Reappraisal coping style prevalence (r=0.35, p=0.039). A subsequent hierarchical multiple regression (Table 4.53) was performed using the significant correlations identified and was found to be overall significant for DBP reactivity (F(10,26) = 2.41, p=0.035). Together the independent variables explain 48% of the variance in PC ranked officers' DBP reactivity, with only the covariate of TTW (p=0.020) being a significant predictor.

Further, SC DBP reactivity was positively associated with years of service (r=0.41, p=0.004) and reduced activity (r=0.42, p=0.040), and negatively correlated with Self-Controlling (r=-0.41, p=0.044) and Positive Reappraisal coping style prevalence (r=-0.52, p=0.010). A subsequent hierarchical multiple regression (Table 4.54) was performed using the significant correlations identified and was found to be overall significant for DBP reactivity (F(8,19) = 2.59, p=0.042). Together the independent variables explain 52% of the variance in SC ranked officers' DBP reactivity, with only the covariate of reduced activity (p=0.026) being a significant predictor, while lifestyle risk factors (p=0.06) and years of service (p=0.05) were also trending towards significance.

Table 4.52 – Significant partial correlations between independent variables and DBP reactivity for probationary constables (n=57), constables (n=99), senior constables (n=53) and sergeants (n=46)

Independent Variables	DBP Reactivity							
	PC		C		SC		Sgt	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*
Years of Service	-	-	-	-	0.41	**0.004**	-	-
Sleep Onset Latency (PSQIC2)	-	-	-	-	-	-	-0.37	**0.015**
Sleep Disturbances (PSQIC5)	-	-	-	-	-	-	-0.36	**0.019**
TTW	-0.54	**0.001**	-	-	-	-	-	-
Distancing (WCQR2)	0.38	**0.024**	-	-	-	-	-	-
Self-Controlling (WCQR3)	-	-	0.32	**0.013**	-0.41	**0.044**	-	-
Seeking Social Support (WCQR4)	0.34	**0.046**	-	-	-	-	-	-
Accepting Responsibility (WCQR5)	0.40	**0.019**	-	-	-	-	-	-
Escape-Avoidance (WCQR6)			0.36	**0.006**	-	-	-	-
Planful Problem-Solving (WCQR7)	0.42	**0.012**	-	-	-	-	-	-
Positive Reappraisal (WCQR8)	0.35	**0.039**	-	-	-0.52	**0.010**	-	-
Reduced Activity (CIS20-4)	-	-	-	-	0.42	**0.040**	-	-

Table 4.52 shows significant results from partial Pearson's correlations between DBP reactivity and other independent variables for the PC, C, SC and Sgt (n=7, n=99, n=53 and n=46 respectively), accounting for the effects of age, sex, WHR and lifestyle risk factors.

Key: CIS20 = Checklist of Individual Strength, DBP = Diastolic Blood Pressure, PSQIC = Pittsburgh Sleep Quality Index Component, TTW = Total Travel Work Time, WCQR = Ways of Coping Questionnaire Revised; p = Level of statistical significance (p=<0.05 (in bold)), - = Not significant

Table 4.53 – Hierarchical multiple regression between DBP reactivity and significantly correlated variables in probationary constables (n=57)

Probationary Constables (n=57)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
DBP Reactivity	0.69	0.48	0.28	5.40	**0.035**
	B	**Std. Error**	**Beta**	**T**	**p**
(Constant)	-42.92	20.65		-2.08	**0.048**
Age	0.25	0.25	0.17	1.00	0.33
Sex	3.70	2.78	0.25	1.33	0.20
WHR	26.21	21.96	0.24	1.19	0.24
Lifestyle Risk Factors (LAQ Part 1)	0.10	0.18	0.08	0.55	0.59
TTW	-0.01	0.01	-0.39	-2.49	**0.020**
Distancing (WCQR2)	0.44	0.39	0.19	1.14	0.27
Seeking Social Support (WCQR4)	-0.10	0.40	-0.05	-0.24	0.81
Accepting Responsibility (WCQR5)	0.55	0.35	0.27	1.59	0.13
Planful Problem-Solving (WCQR7)	0.26	0.45	0.12	0.58	0.57
Positive Reappraisal (WCQR8)	0.11	0.33	0.06	0.33	0.75

Table 4.53 shows hierarchical multiple regression analysis between DBP reactivity and significant variables as determined by partial correlations; total travel work time (TTW) and prevalence of coping mechanisms including Distancing, Seeking Social Support, Accepting Responsibility, Planful Problem-Solving and Positive Reappraisal (WCQR 2, 4, 5, 7 and 8 respectively). The model also accounts for the covariates of age, sex, WHR and lifestyle risk factors for the probationary constables (n=57).

Key: DBP = Diastolic Blood Pressure, LAQ = Lifestyle Appraisal Questionnaire, TTW = Total Travel Work Time, WCQR = Ways of Coping Questionnaire Revised, WHR = Waist-Hip Ratio; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Table 4.54 – Hierarchical multiple regression between DBP reactivity and significantly correlated variables in senior constables (n=53)

Senior Constables (n=53)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
DBP Reactivity	0.72	0.52	0.32	5.41	**0.042**
	B	Std. Error	Beta	T	P
(Constant)	-2.68	18.05		-0.15	0.88
Age	-0.20	0.20	-0.22	-0.96	0.35
Sex	3.39	2.72	0.25	1.25	0.23
WHR	10.53	15.96	0.14	0.66	0.52
Lifestyle Risk Factors (LAQ Part 1)	-0.46	0.23	-0.45	-2.04	0.06
Years of Service	0.77	0.37	0.44	2.07	0.05
Self-Controlling (WCQR3)	-0.50	0.41	-0.28	-1.21	0.24
Positive Reappraisal (WCQR8)	-0.47	0.58	-0.19	-0.81	0.43
Reduced Activity (CIS20-4)	0.93	0.38	0.52	2.42	**0.026**

Table 4.54 shows hierarchical multiple regression analysis between DBP reactivity and significant variables as determined by partial correlations; years of service, Self-Controlling and Positive Reappraisal prevalence (WCQR 3 and 8 respectively), as well as reduced activity (CIS20-4). The model also accounts for the covariates of age, sex, WHR and lifestyle risk factors for the senior constables (n=53).

Key: CIS20 = Checklist of Individual Strength, DBP = Diastolic Blood Pressure, LAQ = Lifestyle Appraisal Questionnaire, WCQR = Ways of Coping Questionnaire Revised, WHR = Waist-Hip Ratio; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

4.2 Discussion: Blood Pressure and Shift Work

This chapter discusses findings with respect to BP and shift work. It examines the significant relationships, including those with stress and fatigue, before also addressing the differences between the identified comparative groups of sex (males vs. females), shift (day vs. night) and occupational rank (probationary constables, constables, senior constables and sergeants).

4.2.1 Blood Pressure and Shift Work (total sample)

In the total sample of general duties police officers assessed, there was a significant increase in SBP and no major change in DBP observed over their twelve hour shift. Changes in shift workers' BP have been recorded in a number of comparable studies; Taiwanese shift workers (n=15) employed under a twelve hour roster similar to this study's cohort were found to have persistently elevated SBP and DBP, as well as delayed BP recovery, via 48 hour holter monitor (Su et al., 2008). Another sample of Japanese shift workers (n=6,711) were also found to exhibit significant increase in their BP from baseline (Suwazono et al., 2008). While this study did not observe a change in police officers' DBP, rotating shift workers have also been found to experience a significant increase in their DBP compared to fixed day workers (n=1,351), although this change was only a relatively small increase of 2mmHg (Sookoian et al., 2007). The majority of studies investigating elevations in shift workers' BP site the prevalence of hypertension; in a sample of German shift workers (n=25,343) it was found that shift working without night shifts (11.5%), followed closely by rotating shift work (11.0%), had a significant association with hypertension (Ohlander et al., 2015). Echoing these results is another study of normotensive firefighters (n=339), 11% of whom had hypertension, with those working more frequent 24 hour shifts exhibiting significantly higher SBP (Choi et al., 2016). These increases in BP have also been found to persist in a large sample of retired Chinese shift workers (n=26,643), presenting with elevated BP and fasting glucose compared to non-shift workers (Guo et al., 2013). Finally, male shift workers (n=121) had a significantly higher average SBP when compared to age-matched day workers, while their sample of females shift workers (n=360) were also found to have an increased prevalence of hypertension (Jermendy et al., 2012). The suggested causative pathways and potential impact of shift work are discussed later.

Conversely, this study's findings also contrast existing literature where shift work had no direct effect upon BP regulation. Virkkunen et al., (2007) found that independently shift work did not result in a significant increase in SBP within their sample of industrially employed men (n=2172). Another study found no significant difference between the BP values of day and shift workers, although this may be due to the significantly younger mean age of their sample (Puttonen et al., 2009). Similarly, a combination of studies on Iranian steel manufacturers (n=5,331) working a mix of shift types found no significant association between shift work and BP or hypertension prevalence (Gholami-Fesharaki et al., 2014a; Gholami-Fesharaki et al., 2014b). However, a more recent study involving some of the original authors, that also appears to expand upon the same cohort (n=3,065) now claims that shift work had a direct effect on BP, body mass index (BMI), fasting blood glucose and triglycerides levels (Hamta et al., 2017). Finally, a population of shift working nurses (n=493), were found to experience no significant change in BP across their shifts (Sfreddo et al., 2010), although hypertension was prevalent in 16% of their cohort. Majority of these authors suggest that any observed alterations in blood pressure regulation is not attributable to shift work, but instead due to established lifestyle risk factors (Costa & Di Milia, 2008), such as age, diet, BMI and smoking habits (Di Lorenzo et al., 2003; Hublin et al., 2010).

The occupation of policing itself may be responsible for the observed changes in BP in this sample of shift workers. A number of studies cite the heightened prevalence of hypertension and increased risk of CVD among police officers (Brown & Trottier, 1995; Rajaratnam et al., 2011; Thayyil et al., 2012), irrespective of shift work. Police officers are exposed to a great volume of occupational risks (Mayhew, 2001a), including critical incidents which are unpredictable in nature. While the release of catecholamines is an essential component of the Hypothalamic-Pituitary-Adrenal (HPA) axis (discussed at length in the subsequent paragraph) (Meerlo et al., 2008), persistent innervation of the sympathetic nervous system (SNS) can have deleterious effects on the cardiovascular system and the neuroendocrine response to maintain BP (Axelrod & Reisine, 1984; Ayada et al., 2015). Occupational noise exposure has also been implicated by a number of studies investigating changes in shift workers (van Kempen et al., 2002; Virkkunen et al., 2007; Puttonen et al., 2009; Rizk et al., 2016). Although not assessed in this study, major findings suggest significant relationships exist between simultaneous noise exposure and shift work (Attarchi et al., 2012), leading to increases in BP and hypertension prevalence.

While some authors disagree about the effects of industrial noise on BP (Kalantary et al., 2015), the consensus is that police officers' occupational sources of stress in general will have effects on BP (Vrijkotte et al., 2000), including the noted organisational stressor of shift work (Perrier & Toner, 1984; Violanti et al., 2012; Bano & Talib, 2014).

This study found a number of significant associations between police officers' BP, perception of stress and coping style prevalence. Stress is suggested to have an effect on an individual's BP regulation (Vrijkotte et al., 2000), believed to be due to a complex interaction between neural stimulation and the neuroendocrine response to maintain homeostasis. The sympathoadrenal cascade of hormones released in concert with the SNS and renin-angiotensin aldosterone system (RAAS) (Ayada et al., 2015), culminates in the liberation of glucocorticoids (mainly cortisol in humans) from the adrenal cortex after stimulation of the HPA axis (Kudielka & Kirschbaum, 2005; Meerlo et al., 2008). The effects of cortisol on the cardiovascular system are well documented (Cannon, 1932; Arnsten, 1998; Anjum et al., 2011), namely its function to elevate BP and HR to overcome sources of stress. However, the HPA axis has been found to malfunction under conditions of chronic stress exposure (Dallman, 1993; Miller et al., 2007), and with the inherently stressful occupation of policing there are further concerns this may be exacerbated by shift work (Monk, 1988; Biggam et al., 1997; Waters & Ussery, 2007). The inverse relationship found by this study with relation to police officers' BP and perception of stress (after accounting for the effects of age, sex, WHR and lifestyle risk factors) was somewhat unexpected based on established literature. It could potentially be explained by the "inverted-U" hypothesis (Morris et al., 2002; Waldstein & Katzel, 2005), wherein both low and high blood pressure have unfavourable impacts on cognitive performance manifesting as high stress perception (Pilgrim, 1994). Alternatively, this negative association with SBP and stress has also been observed in the general population (n=1,666) (Suter et al., 1997), wherein poor stress handling was associated with great consumption of fatty foods and alcohol, thereby leading to higher BP and questioning the role coping plays as a mediator of stress-induced BP dysfunction (Gershon et al., 2009).

Although this samples' subjective coping style prevalence is presented in Chapter 5, there were a number of significant relationships observed between police officers' BP and coping mechanisms. The gradual development of coping strategies among the police population has been suggested to ameliorate the effects of work stress (Evans et al., 1993; Biggam et al., 1997). The novel findings with respect to less preferable long-term coping styles (Distancing and Escape-Avoidance) and SBP, as well as the positive relationship between SBP and DBP reactivity with Confrontive Coping and Accepting Responsibility (respectively), may be due to the nature of the alleged stressor. Shift work is often considered a source of chronic organisational stress; further impacting policing's associated physical, mental and emotional stressors (Kales et al., 2009; Hickman et al., 2011). Failure to cope with chronic stress has been found to result in reduced baroreceptor sensitivity in normal controls (Lucini et al., 2005), as well as decreased BP and neuroendocrine response against repeated stressors (Ayada et al., 2015). The general duties police officers sampled in this study were employed under a twelve hour shift system, and this has proved difficult to cope with in other similar studies (Amendola et al., 2011; Kazemi et al., 2016). Shift work is believed to potentiate work stress by forcing individuals to work during the night, which is naturally the low point for the body's circadian rhythm (Monk, 1988), while also placing time constraints on social and filial obligations of the shift worker (Bøggild & Knutsson, 1999). This work stress has been strongly linked to sleep disturbances (Boivin & Boudreau, 2014), which has also been found to result in increased levels of cortisol following a night of frequently disturbed sleep (Åkerstedt, 2006), thereby further affecting BP regulation. The associations discussed between shift work, stress and BP may also be exacerbated by the inherently poor quality of sleep reported by shift workers (Åkerstedt & Wright, 2009).

Again, while the prevalence and severity of poor sleep quality, sleepiness and fatigue in this sample of police officers is explored in Chapter 6, significant associations were identified between BP and utilised sleep measures (PSQI, ESS, FSS and CIS20). The overwhelming consensus in available literature is that shift work potentiates poor sleep quality and fatigue (Hossain et al., 2003; Shen et al., 2006; Åkerstedt & Wright, 2009), with most studies citing the consequent circadian rhythm dysfunction, reduced sleep quantity and quality leading to changes in cardiovascular health (Åhsberg et al., 2000). The inverse relationships observed in this sample of police officers' SBP and DBP with poor sleep quality, fatigue severity and sleepiness risk contests with existing research. Sleep deprivation has been found to alter neuroendocrine responses to stress and subsequently BP regulation (Meerlo et al., 2008); the combination of habitual short sleep duration and elevated SNS activity has been found to result in increased BP and hypertension (Folkow, 1989; Gangwisch et al., 2006; Javaheri et al., 2008; Nelesen et al., 2008). Working 'out of phase' and prolonging exposure to environmental stressors during the circadian nadir has also been found to have deleterious effects on natural declinations in BP during expected sleep periods (Mosendane et al., 2008; Sherwood et al., 2011; At'kov, 2012; Yadav et al., 2016; Yang et al., 2017). However, the negative associations found by this study may be similar to those observed in patients with chronic fatigue syndrome, who exhibit impaired BP variability (Frith et al., 2012) and reduced cardiac volume (Newton et al., 2016). Alternatively, the relationships observed could be due to the delayed BP recovery time after 12 hour night shifts (Su et al., 2008), or compensation of the cardiovascular system through alterations of vagal tone in dealing with the chronic stressors of shift work and the related sleep debt (Vrijkotte et al., 2000; Jermendy et al., 2012). These novel findings require further research, likely incorporating metabolic measures, to identify the cumulative effect stress, sleep quality, fatigue and sleepiness attributable to shift work has on cardiovascular health and BP maintenance (Violanti et al., 2009).

Overall, the observed changes in BP and significant associations found for this study's general duties police officers were likely due to the complex cardiometabolic impact of shift work. The hypothesised effect shift work has on the cardiovascular system (Åkerstedt et al., 1984) stems from the combination of circadian misalignment (Scheer et al., 2009; Arendt, 2010), disrupted sleep/wake cycle, unhealthy dieting habits and psychosocial stress (Duez & Staels, 2010; Esquirol et al., 2011; Brum et al., 2015). Shift workers have often been found to be at a significantly greater risk of CVD (Vyas et al., 2012; Hemamalini et al., 2013), which remains the leading cause of death in industrialised countries (Bøggild & Knutsson, 1999). The causative pathways have been discussed (Puttonen et al., 2010), with the majority agreeing the disruption of natural diurnal variations in the cardiovascular system resulting in poor coping with adverse shift systems. Alterations in circulating leptin and ghrelin levels (Van Cauter et al., 2008; Scheer et al., 2009) results in the predominance of poor lifestyle coping mechanisms (Zhao & Turner, 2008), such as high carbohydrate and fat diets (Asare-Anane et al., 2015), as well as excessive alcohol consumption and smoking all attributable to shift working (Mullington et al., 2009; Ohlander et al., 2015). These result in an increased risk of obesity and diabetes (Broussard & Brady, 2010; Broussard & Van Cauter, 2016), evidenced by impaired glucose metabolism (Spiegel et al., 1999; Suwazono et al., 2008), elevated blood glucose levels and dyslipidaemia (Bøggild & Knutsson, 1999; Mosendane et al., 2008; Garbarino & Magnavita, 2015; Hamta et al., 2017), thereby further affecting shift workers' BP and cardiovascular health. The combination of these is typified by the metabolic syndrome (Lin et al., 2009), estimated to predominate in 3.0-16.8% of shift working police populations (Yoo & Franke, 2010; Thayyil et al., 2012; Chang et al., 2015), persisting even after the shift workers retire (Guo et al., 2015). This vascular stress compounded by compromised sleep quality (Meier-Ewert et al., 2004) results in elevated inflammatory markers (Sookoian et al., 2007; Kim et al., 2016b), leading to the increased levels of resistin (Burgueno et al., 2010; Morris et al., 2016), arterial stiffness (Jankowiak et al., 2016) and accelerated atherosclerotic plaque formation observed (Haupt et al., 2008; Puttonen et al., 2009). Future studies on general duties police officers must incorporate more robust methods of assessing the potential impact shift work may have upon their BP regulation and cardiovascular health.

However, the majority of the risks associated with shift work are considered modifiable risk factors (Van Cauter et al., 2008). It is the responsibility of employers to ensure the most optimum conditions to prevent or mend ongoing cardiovascular risks associated with shift work. Researchers have suggested screening programmes to identify and educate at risk individuals (Vyas et al., 2012; Kim et al., 2016a), incorporation of napping schedules to ameliorate persistent fatigue issues (Humm, 2008; Ficca et al., 2010), or even ratifying existing shift schedules to account for workload (Brum et al., 2015; Choi et al., 2016). Fortunately, the NSW Police Force already incorporates a rapidly rotating, clockwise-oriented roster system (Achterstraat, 2007), suggested to be the most beneficial option (Lavie et al., 1992; Knauth, 1993), as well as a number of health and lifestyle motivator interventions. This may also explain that, while significant, the change in SBP for general duties police officers was relatively small. The findings of this study suggest further research is required and have far reaching consequences, not only for the occupational health and safety of our police forces, but for all shift workers on a global scale.

4.2.2 Blood Pressure and Shift Work (comparisons)

This section focuses on the differences which exist between the established sub-groups of sex (male vs. female), shift (day vs. night) and rank (probationary constable, constable, senior constable and sergeants). As such, the majority of the discussions with respect to BP and shift work already presented will not be repeated again.

4.2.2.1 Blood Pressure: Impact of sex

In this sample of general duties police officers, only females were found to experience a significant increase in their SBP when compared to their male peers. Expectedly, all cardiac variables (except DBP reactivity) significantly differed between the sexes, with males having higher pre- and post-shift SBP and DBP, as well as SBP reactivity and WHR. This is likely due to natural variations in body mass, such as muscle and skeletal size, as well as various sex hormones predominating in each sex that are involved in the regulation of BP (Reckelhoff, 2001). However, the finding that only females exhibited a significant increase in their BP but not males goes against a lot of available literature (Su et al., 2008; Suwazono et al., 2008). Similar studies involving nurses (n=493, 88.2% female) found no significant change in BP or prevalence of hypertension attributable to shift work (Sfreddo et al., 2010). By comparison, another study of light industry and public service shift workers found only males had significantly higher SBP than their day-working counterparts, while female shift workers had a higher prevalence of hypertension (Jermendy et al., 2012). Although both groups were exposed to the same shift work roster (rapidly-rotating, clockwise oriented twelve hour shifts) (Achterstraat, 2007), the differences observed may be due to sexual dimorphisms in their response to stress and fatigue, as well as gendered metabolic risk.

Although the vast majority of the associations with BP discussed earlier in this chapter presented appeared only in male police officers (likely due to them being the larger proportion), females' SBP appears to have been more affected by shift work. Age, or more accurately age with respect to menopausal status, appears to be a big factor in females' response to shift work's effect on cardiovascular health and stress response (Maranon & Reckelhoff, 2013). Studies have found that men and women perceive stress and cope differently; female officers often report feeling more vulnerable to organisational and operational stressors (Acquadro-Maran et al., 2015), and employ more emotion-focused coping than their male peers (Balmer et al., 2014; Adole et al., 2015). Neurobiological mechanisms, including limbic regions like the hippocampus and amygdala, have been found to exhibit sexual dimorphism (Herman & Cullinan, 1997), resulting in different cardiac responses based on the sexes' processing of sex via the HPA axis (Kudielka & Kirschbaum, 2005; Kajantie & Phillips, 2006). Finally, female officers may be more affected by the cumulative sleep loss and circadian dysfunction associated with shift work (Jermendy et al., 2012), presenting in this sample as an increase in their SBP, thereby increasing their risk of metabolic diseases and CVD (Lin et al., 2009; Guo et al., 2015).

4.2.2.2 Blood Pressure: Impact of shift

When comparing within this sample of general duties police officers based on their shift at time of assessment (day or night), there were a number of surprising results. Firstly, only day workers were found to experience a significant increase in their SBP, as well as having significantly lower pre-shift SBP and DBP, compared to their night-shift working peers. Also, similar to the differences with respect to sex, the majority of the previously discussed associations with BP were only found in the day-shift working cohort (likely due to them being the larger proportion). The natural diurnal fluctuations anticipated in BP were not observed (Carev et al., 2011), wherein BP should be lower during a night period, however this is likely due to the circadian misalignment of having to undertake shift work (Sherwood et al., 2011; At'kov, 2012). Counter intuitively, the night-shift working police officers were also found to be significantly older and have a higher WHR, both suggested to cause increases in BP (Di Lorenzo et al., 2003; Carrington et al., 2010). Finally, the fact that significant associations were found for one group but not the other was unexpected (Anjum et al., 2015), as all police officers assessed were employed under the same twelve hour, clockwise-oriented, rapidly rotating shift system (Achterstraat, 2007). The issue with relating these findings with respect to available literature is that majority of the studies compare fixed day and rotating shift workers, and hence do not offer much insight. Crime rate have been found to differ by time of day (Felson & Poulsen, 2003; Gottfredson & Soulé, 2004), so this disparity may be explained by actual task performance during shift (Balmer et al., 2014; Ma et al., 2015; Vasquez-Trespalacios et al., 2016), as well as whether they were assessed during their first or second day/night shift in their roster (Ramey et al., 2012). This may be why the cardiovascular function of one group appears more affected by the cardiometabolic impact of shift work, and requires further research to ensure the health and wellbeing of police officers in our 24-hour modern society.

4.2.2.3 Blood Pressure: Impact of rank

Comparisons were also made between general duties police officers sampled based on their occupational rank. These included probationary constables, constables, senior constables and sergeants, all currently working under the same twelve hour shift roster. Only senior constables experienced a significant increase in their BP, while sergeants were found to have significantly higher cardiac values than all other ranks assessed, as well as higher WHR. While some of the significant differences found were expected, such as sergeants being significantly older and having greater years of service than younger/less experienced ranks, the differences with respect to BP are likely due to the known changes attributable to age and abdominal obesity.

Gradual increases in BP are to be expected over the course of an individual's lifespan, which has been suggested to be due to the natural process of aging (Flynn et al., 1992; Carrington et al., 2010). As we age there is an increased incidence of CVD, shown in Figure 4.1, with 13% of those aged between 35 and 44 years reporting a CVD compared to 63% found among those aged 75 years and older (Australian Bureau of Statistics, 2006). Some authors have found a 20/10mmHg increase (on average) in BP from age 35 to 65 years (William & Kannel, 1996), while others have reported only a 14% increase in SBP from age 20 to 90 years old (Vaitkevicius et al., 1993). These findings are further supported by the linear rise in BP from ages 30 to 84 (Franklin et al., 1997), although after 60 years of age there is a gradual decline in DBP while SBP continues to rise. There are a myriad of physiological justifications behind age-associated increases in BP, including increases in peripheral vascular resistance (Franklin et al., 1997), which may occur due to various mechanisms including stiffening of the arterial tree (Vaitkevicius et al., 1993). However, the concern is this may be further compounded by the deleterious effects of shift work on the cardiovascular system (Haupt et al., 2008; Jankowiak et al., 2016; Morris et al., 2016).

Figure 4.1 – Reported prevalence of CVD in the Australian population

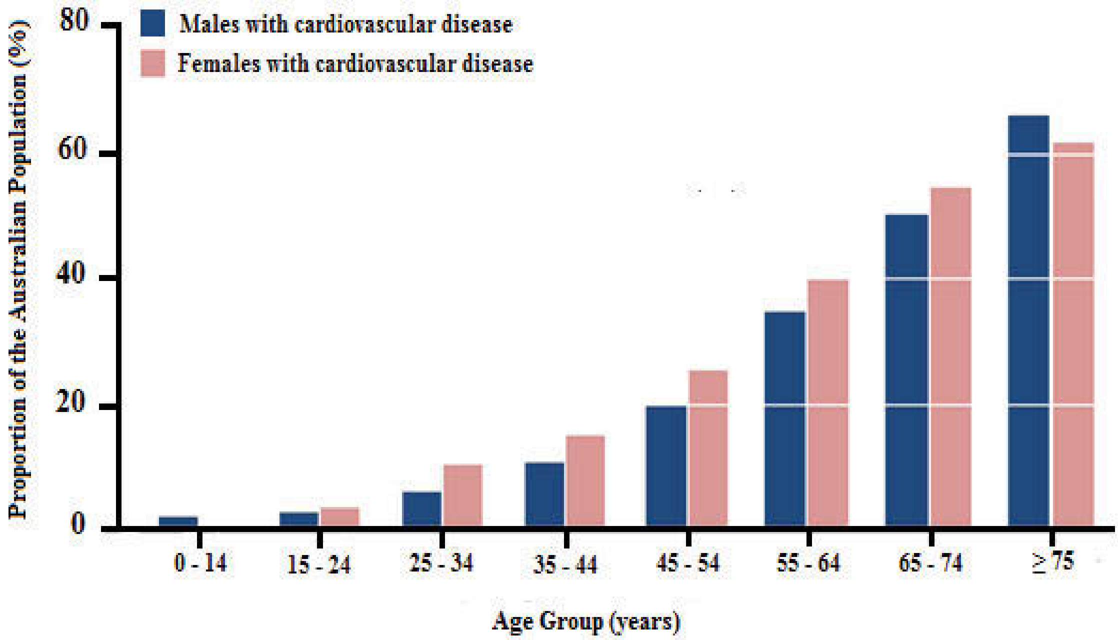

Figure 4.1 shows the reported incidents of cardiovascular disease for the Australian population when distributed by gender. Females have the greater prevalence of cardiovascular diseases when compared to men for all age groups except for those 75 years and older. Adapted from (Australian Bureau of Statistics, 2006).

WHR is a suggested estimate of cardiovascular and metabolic health (World Health Organization, 2011), and the significantly higher finding for sergeants may also be responsible for the differences observed in their elevated cardiac scores. Many authors have cited the increased prevalence of obesity and greater risk of diabetes among shift workers (Di Lorenzo et al., 2003; Sookoian et al., 2007), and how this impacts cardiovascular health. Among available literature, it is shift workers' propensity for consumption of cholesterol rich food, increased rate of tobacco smoking and decreased physical activity during the night shift that are primarily responsible for their increased prevalence of abdominal obesity (Antunes et al., 2010; Esquirol et al., 2011). Further suggestions have been proposed that an individual's tolerance to shift work will change as they age (Costa & Di Milia, 2008), with the critical age being between 45 and 60 years. Chronobiological aspects, including increased prevalence of sleep disturbances and the circadian rhythm shift experienced as people age (Härmä, 1995), which may result in reduced tolerance to longer work hours (Bourdouxhe et al., 1999). With the population of Australians aged 65 years and older expecting to almost double from 13% to 23%

between 2010 and 2030, the working population is anticipated to consequently age (Australian Government, 2010). The combination of these factors may be further exacerbated by the inherently stressful occupation of policing (Perrier & Toner, 1984; Shane, 2010), and as such must be considered when determining suitable roster models to account for all police officers' cardiovascular health.

4.3 Conclusion: Blood Pressure and Shift Work

The current study identified a number of significant associations between cardiac measures and independent variables among shift working police officers, as well as differences based on their sex, shift and occupational rank. While significant, the observed increases in SBP for the total sample, female, day-shift and SC ranked officers were relatively small. However, these findings conform to similar literature which has investigated the potential link between shift work and BP regulation (Su et al., 2008; Suwazono et al., 2008; Jermendy et al., 2012; Guo et al., 2013; Hamta et al., 2017), with the probable causative mechanisms discussed. When comparing the general duties police officers between subgroups, a number of significant differences were also identified; and although some were expected (due to sexual dimorphism or circadian placement), others require further insight beyond the scope of this study. Finally, a great deal of significant correlations were found with BP, even after accounting for the known covariates of age, sex, WHR and lifestyle risk factors (LAQ Part 1). Differences between subgroups' associations, as well as the particularly novel findings with regards to sleep quality (PSQI) and fatigue (FSS), require additional research. By incorporating more physiological measurements, thereby following dynamic changes during their regular shift, greater insight may be made into what degree shift work may be impacting police officers' cardiovascular health, potentially benefitting not only the NSW Police Force but the global shift working population. Refer to Table 4.55, Table 4.56, Table 4.57 and 4.58 for a summary of the significant associations between cardiac measures and independent variables for each sample.

Table 4.55 – Summary of significant partial correlations between BP and independent variables for the total sample (N=255)

	Independent Variables	SBP	DBP	SBP Reactivity	DBP Reactivity
Total Sample (N=255)	Perception of Stress (LAQ Part 2)	-	-		
	Subjective Sleep Quality (PSQIC1)				-
	Sleep Disturbances (PSQIC5)	-	-		-
	Sleep Medication Usage (PSQIC6)	-	-	-	
	Daytime Dysfunction (PSQIC7)	-	-		-
	PSQI Global	-	-		
	Sleepiness Risk (ESS)		-		
	Fatigue Severity (FSS)	-	-		
	TTW				-
	Confrontive Coping (WCQR1)			+	
	Distancing (WCQR2)	-			
	Accepting Responsibility (WCQR5)				+
	Escape-Avoidance (WCQR6)	-			
	Subjective Fatigue (CIS20-1)	-			
	Reduced Concentration (CIS20-2)	-	-		
	Total Fatigue (CIS20-Total)	-			

Table 4.55 summarises the significant partial Pearson's correlations between BP values and other variables from the LAQ, PSQI, ESS, FSS, WCQR and CIS20 for the total sample (N=255), after accounting for the effects of age, sex, WHR and lifestyle risk factors.

Key: CIS20 = Checklist of Individual Strength, DBP = Diastolic Blood Pressure, ESS = Epworth Sleepiness Scale, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, SBP = Systolic Blood Pressure, TTW = Total Travel Work Time, WCQR = Ways of Coping Questionnaire Revised, WHR = Waist-Hip Ratio; + = Positive correlation; - = Negative correlation

Table 4.56 – Summary of significant partial correlations between BP and independent variables for male (n=179) and female (n=76) police officers

	Independent Variables	SBP	DBP	SBP Reactivity	DBP Reactivity
Male (n=179) vs. Female (n=76) Police Officers	Perception of Stress (LAQ Part 2)	-	-		
	Subjective Sleep Quality (PSQIC1)	-	-		-
	Sleep Onset Latency (PSQIC2)	-	- / +		
	Sleep Duration (WCQR3)		-		
	Sleep Disturbances (PSQIC5)	-	-		-
	Sleep Medication Usage (PSQIC6)	-	-	-	-
	Daytime Dysfunction (PSQIC7)	-	-		-
	PSQI Global	-	-		-
	Sleepiness Risk (ESS)	-	- / -	-	-
	Fatigue Severity (FSS)	-	-		-
	TTW		+ / -	-	-
	Distancing (WCQR2)		-	-	
	Self-Controlling (WCQR3)		-		+
	Seeking Social Support (WCQR4)	-			
	Accepting Responsibility (WCQR5)				+
	Subjective Fatigue (CIS20-1)	-	-		
	Reduced Concentration (CIS20-2)	-	-		
	Reduced Motivation (CIS20-3)	-			
	Reduced Activity (CIS20-4)	-			

Table 4.56 summarises the significant partial Pearson's correlations between BP values and other variables from the LAQ, PSQI, ESS, FSS, WCQR and CIS20 for the male (shown in black) (n=179) and female (shown in red) (n=76) police officers, after accounting for the effects of age, WHR and lifestyle risk factors.

Key: CIS20 = Checklist of Individual Strength, DBP = Diastolic Blood Pressure, ESS = Epworth Sleepiness Scale, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, SBP = Systolic Blood Pressure, TTW = Total Travel Work Time, WCQR = Ways of Coping Questionnaire Revised, WHR = Waist-Hip Ratio; + = Positive correlation; - = Negative correlation

Table 4.57 – Summary of significant partial correlations between BP and independent variables for police officers working a day (n=148) or night shift (n=107)

Day (n=148) vs. Night Shift (n=107) Police Officers	Independent Variables	SBP	DBP	SBP Reactivity	DBP Reactivity
	Perception of Stress (LAQ Part 2)	-	-		
	Sleep Disturbances (PSQIC5)	-	-		
	Sleep Medication Usage (PSQIC6)		-		
	Daytime Dysfunction (PSQIC7)		-		
	PSQI Global		-		
	Sleepiness Risk (ESS)		-		
	Fatigue Severity (FSS)	-	-		
	TTW				-
	Distancing (WCQR2)			+	
	Escape-Avoidance (WCQR6)	-			
	Subjective Fatigue (CIS20-1)	-			

Table 4.57 summarises the significant partial Pearson's correlations between BP values and other variables from the LAQ, PSQI, ESS, FSS, WCQR and CIS20 for the day (shown in black) (n=148) and night shift (shown in red) (n=107) police officers, after accounting for the effects of age, sex, WHR and lifestyle risk factors.

Key: CIS20 = Checklist of Individual Strength, DBP = Diastolic Blood Pressure, ESS = Epworth Sleepiness Scale, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, SBP = Systolic Blood Pressure, TTW = Total Travel Work Time, WCQR = Ways of Coping Questionnaire Revised, WHR = Waist-Hip Ratio; + = Positive correlation; - = Negative correlation

Table 4.58 – Summary of significant partial correlations between BP and independent variables for probationary constables (n=57), constables (n=99), senior constables (n=53) and sergeants (n=46)

Probationary Constables (n=57), Constables (n=99), Senior Constables (n=53) vs. Sergeants (n=46)	Independent Variables	SBP	DBP	SBP Reactivity	DBP Reactivity
	Years of Service				+
	Perception of Stress (LAQ Part 2)	-	-		
	Subjective Sleep Quality (PSQIC1)	-	-	-	
	Sleep Onset Latency (PSQIC2)				-
	Sleep Duration (WCQR3)	-	-		
	Sleep Disturbances (PSQIC5)		-		-
	Sleep Medication Usage (PSQIC6)		-		
	Daytime Dysfunction (PSQIC7)	-	-		
	PSQI Global	-	- / -	-	
	Sleepiness Risk (ESS)		- / -		
	Fatigue Severity (FSS)	- / -	- / -		
	TTW				-
	Confrontive Coping (WCQR1)			+	
	Distancing (WCQR2)				+
	Self-Controlling (WCQR3)			+	+ / -
	Seeking Social Support (WCQR4)		-		+
	Accepting Responsibility (WCQR5)	-			+
	Escape-Avoidance (WCQR6)	-	-	+	+
	Planful Problem-Solving (WCQR7)		+		+
	Positive Reappraisal (WCQR8)	+	+		+ / -
	Subjective Fatigue (CIS20-1)	-			
	Reduced Concentration (CIS20-2)		-		
	Reduced Activity (CIS20-4)				+

Table 4.58 summarises the significant partial Pearson's correlations between BP values and other variables from the LAQ, PSQI, ESS, FSS, WCQR and CIS20 for PC (shown in black) (n=57), C (shown in red) (n=99), SC (shown in green) (n=53) and Sgt (shown in blue) (n=46), after accounting for the effects of age, sex, WHR and lifestyle risk factors.

Key: C = Constable, CIS20 = Checklist of Individual Strength, DBP = Diastolic Blood Pressure, ESS = Epworth Sleepiness Scale, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PC = Probationary Constable, PSQIC = Pittsburgh Sleep Quality Index Component, SBP = Systolic Blood Pressure, SC = Senior Constable, Sgt = Sergeant, TTW = Total Travel Work Time, WCQR = Ways of Coping Questionnaire Revised, WHR = Waist-Hip Ratio; + = Positive correlation; - = Negative correlation

Chapter 5 Stress, Coping and Shift Work

5.1 Results: Stress, Coping and Shift Work

A total of 225 police officers were recruited for the present study which, after selection criteria was applied (Section 3.3), provided an inclusive sample of 159 (Table 3.1 in Section 3.3 details subjects' reasons for exclusion). These participants were added to an existing data base of police officers, obtained using a similar experimental protocol conducted by this researcher and the Neuroscience Research Unit of the University of Technology Sydney (UTS) (Elliott & Lal, 2016).

This chapter reports the total samples' (N=255) stress and coping style information, before presenting Pearson's correlations and subsequent multiple regressions (detailed in Section 3.6) to determine the relationship between perception of stress and other variables. Finally, further descriptive statistics, associations and comparisons are determined and compared within four distinct sample populations; males (n=179) vs. females (n=76), day (n=148) vs. night shift (n=107) and rank (probationary constable, constable, senior constable and sergeant; n=57, 99, 53 and 46 respectively).

5.1.1 Results: Stress, Coping and Shift Work (total sample)

This section presents the results in the context of the total sample (N=255). Their perception of stress and coping style prevalence, associated correlations and regression analyses follow.

5.1.1.1 Stress and Coping Questionnaire Data (total sample)

Mean (± SD) perception of stress and coping style prevalence is provided for the total sample (N=255) (Table 5.1). Perception of stress was determined by Part 2 of the Lifestyle Appraisal Questionnaire (LAQ Part 2), by adding values attributed to selectable criteria with a maximum potential score of 75 (Craig et al., 1996). The mean perception of stress score (LAQ Part 2) of 15.47 ± 9.26 was below the normative threshold value (18.80 ± 9.30) for their age bracket (presented in Section 4.1.1.1, Table 4.1). Figure 5.1 shows the distribution of perception of stress (LAQ Part 2) scores for the total sample, which appears skewed to the left, with 32% of police officers scoring greater than the normative threshold value (Craig et al., 1996).

Coping style prevalence was assessed by the Ways of Coping Questionnaire Revised (WCQR) (Folkman et al., 1986), with the relative score calculated indicating the likelihood of employing a specific coping style over other for the total sample (detailed in Section 3.4.2.2). Represented as a percentage, Planful-Problem Solving (15.39%), Seeking Social Support (13.58%), Self-Controlling (13.55%) and Distancing (12.26%) were the most prevalent coping styles employed by the police officers assessed, while Accepting Responsibility (12.11%), Confrontive Coping (11.47%), Positive Reappraisal (11.08%) and Escape-Avoidance (10.54%) were the least frequently utilised.

Table 5.1 – Mean perception of stress and coping style prevalence for the total sample (N=255)

Total sample (N=255)	Dependant Variable	Mean ± SD
	Perception of Stress (LAQ Part 2)	15.47 ± 9.26
	Coping Style (WCQR)	**Prevalence (Percentage)**
	Confrontive Coping	11.47
	Distancing	12.26
	Self-Controlling	13.55
	Seeking Social Support	13.58
	Accepting Responsibility	12.11
	Escape-Avoidance	10.54
	Planful Problem-Solving	15.39
	Positive Reappraisal	11.08

Table 5.1 shows mean perception of stress and coping style prevalence for the total sample of general duties police officers (N=255). The maximum score for the LAQ Part 2 (perception of stress) is 75, with greater scores indicating a greater perception of stress (Craig et al., 1996). Coping style prevalence describes the proportion of effort represented for each type of coping, with higher relative scores indicating a greater employment of certain coping styles over others as a percentage (Folkman et al., 1986).

Key: LAQ = Lifestyle Appraisal Questionnaire, WCQR = Ways of Coping Questionnaire Revised; SD =Standard Deviation, ± = Plus and minus

Figure 5.1 – Frequency distribution of the perception of stress for the total sample (N=255)

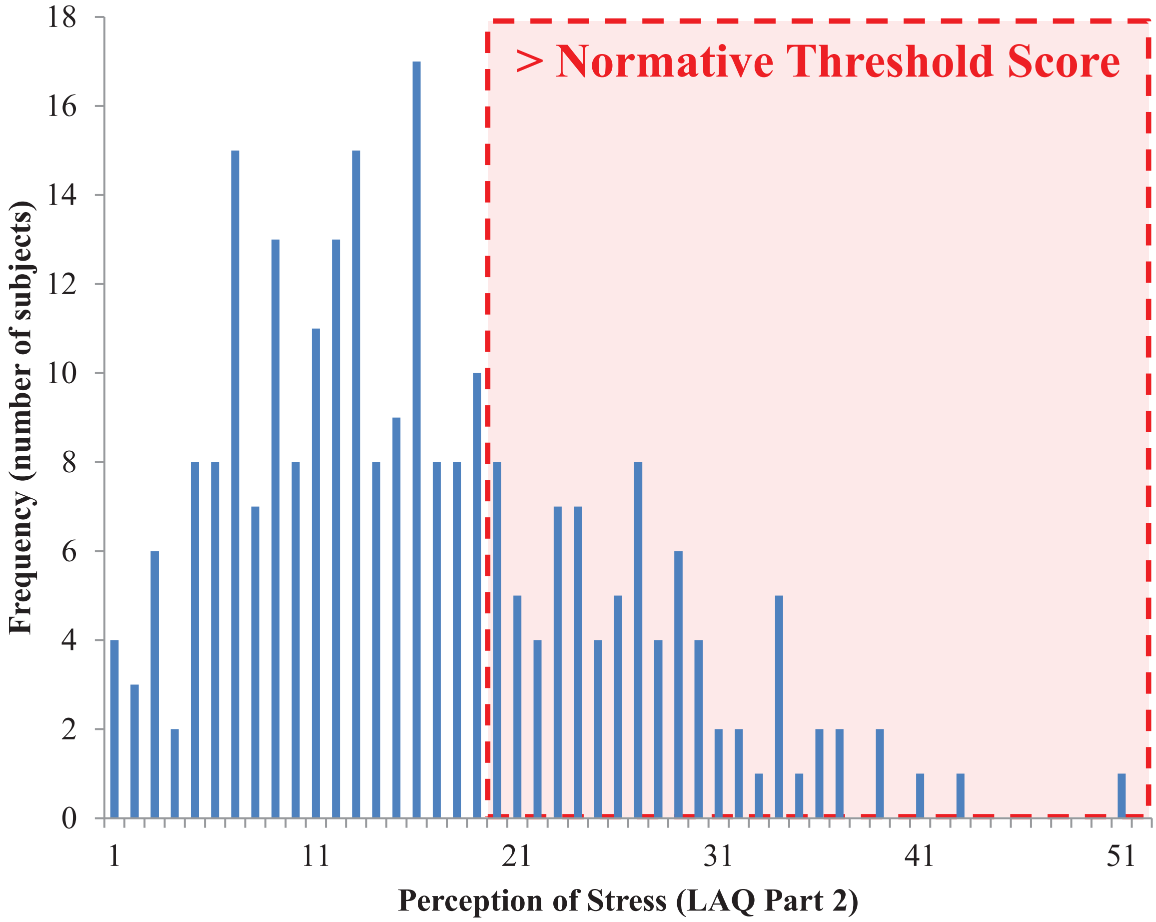

Figure 5.1 depicts the perception of stress (LAQ Part 2) scores for the total sample of general duties police officers (N=255). The histogram is skewed to the left, with the majority of subjects scoring within the lower bands for perception of stress (Craig et al., 1996).

Key: LAQ = Lifestyle Appraisal Questionnaire

5.1.1.2 Stress and Coping Associations & Regression Analyses (total sample)

Pearson's correlations were performed to identify the relationship between subjects' perception of stress (LAQ Part 2) and other independent variables. Where three or more independent variables were found to be significantly correlated with the dependant variable of stress perception, consequent multiple regressions were performed.

Police officers' perception of stress was negatively associated with their length of service ($r=-0.14$, $p=0.023$) (Table 5.2), while lifestyle risk factors (LAQ Part 1) was positively correlated ($r=0.32$, $p<0.001$). Similarly, the following coping styles (WCQR) were all positively linked to perception of stress; Confrontive Coping ($r=0.17$, $p=0.037$), Distancing ($r=0.23$, $p=0.004$), Self-Controlling ($r=0.29$, $p<0.001$), Accepting Responsibility ($r=0.26$, $p=0.001$) and Escape-Avoidance ($r=0.49$, $p<0.001$). A subsequent multiple regression (Table 5.3) was performed using the significant correlations identified and was found to be overall significant for perception of stress ($F(7,151) = 10.83$, $p<0.001$). Together the independent variables explain 33% of the variance in stress perception, with lifestyle risk factors ($p<0.001$) and Escape-Avoidance coping style prevalence ($p<0.001$) being the significant predictors.

Table 5.2 – Significant correlations between independent variables and perception of stress for the total sample (N=255)

Total sample (N=255)	Independent Variables	Perception of Stress (LAQ Part 2)	
		r	***p***
	Years of Service	-0.14	**0.023**
	Lifestyle Risk Factors (LAQ Part 1)	0.32	**<0.001**
	Confrontive Coping (WCQR1)	0.17	**0.037**
	Distancing (WCQR2)	0.23	**0.004**
	Self-Controlling (WCQR3)	0.29	**<0.001**
	Accepting Responsibility (WCQR5)	0.26	**0.001**
	Escape-Avoidance (WCQR6)	0.49	**<0.001**

Table 5.2 shows significant results from Pearson's correlations between perception of stress (LAQ Part 2) and other independent variables for the total sample (N=255).

Key: LAQ = Lifestyle Appraisal Questionnaire, WCQR = Ways of Coping Questionnaire Revised; p = Level of statistical significance (p=<0.05 (in bold))

Table 5.3 – Multiple regression between perception of stress and significantly correlated variables in the total sample (N=255)

Total Sample (N=255)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Perception of Stress	0.58	0.33	0.30	7.73	**<0.001**
	B	Std. Error	Beta	T	p
(Constant)	0.18	3.18		0.06	0.96
Years of Service	-0.11	0.09	-0.09	-1.27	0.20
Lifestyle Risk Factors (LAQ Part 1)	0.44	0.11	0.28	4.05	**<0.001**
Confrontive Coping (WCQR1)	-0.35	0.24	-0.13	-1.47	0.14
Distancing (WCQR2)	-0.23	0.25	-0.08	-0.92	0.36
Self-Controlling (WCQR3)	0.21	0.22	0.09	0.95	0.34
Accepting Responsibility (WCQR5)	0.16	0.26	0.05	0.61	0.54
Escape-Avoidance (WCQR6)	0.95	0.19	0.48	5.03	**<0.001**

Table 5.3 shows multiple regression analysis between perception of stress (LAQ Part 2) and significant variables as determined by Pearson's correlations; lifestyle risk factors (LAQ Part 1), Confrontive Coping, Distancing, Self-Controlling, Accepting Responsibility and Escape-Avoidance coping style prevalence for the total sample (N=255).

Key: LAQ = Lifestyle Appraisal Questionnaire, WCQR = Ways of Coping Questionnaire Revised; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

5.1.2 Results: Stress, Coping and Shift Work (sex comparison)

This section presents the results in the context of comparing the sexes; 179 male and 76 female general duties police officers made up the total sample (N=255). Their perception of stress and coping style prevalence, associated correlations and regression analyses follow.

5.1.2.1 Stress and Coping Questionnaire Data (sex comparison)

Mean (± SD) perception of stress and coping style prevalence for male (n=179) and female (n=76) police officers are provided in Table 5.4. Independent sample t-tests performed found females had a significantly higher usage of Seeking Social Support (p=0.014) and Escape-Avoidance (p=0.024) coping styles than their male peers. Both groups perception of stress (LAQ Part 2) scores were below the normative threshold value suggested by Craig and colleagues (1996).

Table 5.4 – Mean perception of stress and coping style prevalence for male (n=179) and female (n=76) police officers

Perception of Stress (LAQ Part 2)	Male (n=179)	Female (n=76)
	14.98 ± 9.25	16.63 ± 9.25
Coping Style	**Prevalence (Percentage)**	
Confrontive Coping	11.53	11.36
Distancing	12.41	11.96
Self-Controlling	13.69	13.27
Seeking Social Support*	13.23	14.30
Accepting Responsibility	12.28	11.78
Escape-Avoidance*	10.19	11.27
Planful Problem-Solving	15.53	15.13
Positive Reappraisal	11.15	10.94

Table 5.4 shows mean perception of stress (LAQ Part 2) and coping style prevalence for the male and female general duties police officers (n=179 and n=76 respectively). Independent sample t-tests were performed, with Seeking Social Support and Escape-Avoidance coping style prevalence all being significantly different based on sex. The maximum score for the LAQ Part 2 (perception of stress) is 75, with greater scores indicating an increased likelihood of developing a chronic illness (Craig et al., 1996).

Key: LAQ = Lifestyle Appraisal Questionnaire, WCQR = Ways of Coping Questionnaire Revised; n=Sample size, * = Level of statistical significance ($p<0.05$)

5.1.2.2 Stress and Coping Associations & Regression Analyses (sex comparison)

Pearson's correlations were performed to identify the relationship between male and females' perception of stress (LAQ Part 2) and other independent variables. Where three or more independent variables were found to be significantly correlated with the dependant variable of stress perception, consequent multiple regressions were performed.

Perception of stress was found to have a number of significant relationships with other independent variables when comparing between the sexes (Table 5.5). Male police officers' stress perception was positively associated with lifestyle risk factors (LAQ Part 1) ($r=0.36$, $p<0.001$) and the following coping styles' prevalence; Confrontive Coping ($r=0.20$, $p=0.038$), Distancing ($r=0.23$, $p=0.018$), Self-Controlling ($r=0.33$, $p<0.001$), Accepting Responsibility ($r=0.28$, $p=0.004$) and Escape-Avoidance ($r=0.46$, $p<0.001$). A subsequent multiple regression (Table 5.6) was performed using the significant correlations identified and was found to be overall significant for perception of stress ($F(6,101) = 9.09$, $p<0.001$). Together the independent variables explain 35% of the variance in male officers' stress perception, with lifestyle risk factors ($p<0.001$) and Escape-Avoidance prevalence ($p<0.001$) being the significant predictors.

By comparison, female police officers' perception of stress was similarly positively associated with Escape-Avoidance coping style prevalence ($r=0.52$, $p<0.001$), while also negatively correlated with age ($r=-0.29$, $p=0.010$) and years of service ($r=-0.28$, $p=0.013$). A subsequent multiple regression (Table 5.7) was performed using the significant correlations identified and was found to be overall significant for perception of stress ($F(3,47) = 6.38$, $p=0.001$). Together the independent variables explain 29% of the variance in female officers' stress perception, with only the covariate of Escape-Avoidance prevalence ($p<0.001$) being a significant predictor.

Table 5.5 – Significant correlations between independent variables and perception of stress for male (n=179) and female (n=76) police officers

Independent Variables	**Perception of Stress (LAQ Part 2)**			
	Male (n=179)		**Female (n=76)**	
	r	***p***	***r***	***p***
Years of Age	-	-	-0.29	**0.010**
Years of Service	-	-	-0.28	**0.013**
Lifestyle Risk Factors (LAQ Part 1)	0.36	**<0.001**	-	-
Confrontive Coping (WCQR1)	0.20	**0.038**	-	-
Distancing (WCQR2)	0.23	**0.018**	-	-
Self-Controlling (WCQR3)	0.33	**<0.001**	-	-
Accepting Responsibility (WCQR5)	0.28	**0.004**	-	-
Escape-Avoidance (WCQR6)	0.46	**<0.001**	0.52	**<0.001**

Table 5.5 shows significant results from Pearson's correlations between perception of stress (LAQ Part 2) and other independent variables for the male and female general duties police officers (n=179 and n=76 respectively).

Key: LAQ = Lifestyle Appraisal Questionnaire, WCQR = Ways of Coping Questionnaire Revised; n=Sample size, p = Level of statistical significance (p=<0.05 (in bold))

Table 5.6 – Multiple regression between perception of stress and significantly correlated variables in male police officers (n=179)

Male (n=179)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Perception of Stress	0.59	0.35	0.31	7.67	**<0.001**
	B	**Std. Error**	**Beta**	**T**	**p**
(Constant)	-2.22	3.65		-0.61	0.55
Lifestyle Risk Factors (LAQ Part 1)	0.52	0.12	0.35	4.14	**<0.001**
Confrontive Coping (WCQR1)	-0.15	0.32	-0.05	-0.48	0.63
Distancing (WCQR2)	-0.43	0.31	-0.14	-1.38	0.17
Self-Controlling (WCQR3)	0.22	0.26	0.10	0.83	0.41
Accepting Responsibility (WCQR5)	0.15	0.32	0.05	0.46	0.65
Escape-Avoidance (WCQR6)	1.02	0.26	0.48	3.86	**<0.001**

Table 5.6 shows multiple regression analysis between perception of stress (LAQ Part 2) and significant variables as determined by Pearson's correlations; lifestyle risk factors (LAQ Part 1), Confrontive Coping, Distancing, Self-Controlling, Accepting Responsibility and Escape-Avoidance coping style prevalence for the male general duties police officers (n=179).

Key: LAQ = Lifestyle Appraisal Questionnaire, WCQR = Ways of Coping Questionnaire Revised; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Table 5.7 – Multiple regression between perception of stress and significantly correlated variables in female police officers (n=76)

Female (n=76)	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**p**
Perception of Stress	0.54	0.29	0.24	8.05	**0.001**
	B	**Std. Error**	**Beta**	**T**	**p**
(Constant)	8.71	6.60		1.32	0.19
Years of Age	-0.13	0.17	-0.11	-0.78	0.44
Years of Service	-0.10	0.20	-0.07	-0.50	0.62
Escape-Avoidance (WCQR6)	0.87	0.25	0.46	3.43	**0.001**

Table 5.7 shows multiple regression analysis between perception of stress and significant variables as determined by Pearson's correlations; age, years of service and Escape-Avoidance coping style prevalence for the female general duties police officers (n=76).

Key: WCQR = Ways of Coping Questionnaire Revised; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

5.1.3 Results: Stress, Coping and Shift Work (shift comparison)

This section presents the results in the context of comparing the general duties police officers based on the shift they were working at time of assessment; 148 were working a day shift (0600 – 1800) and 107 were working a night shift (1800 – 0600) that comprise the total sample (N=255). Their perception of stress and coping style prevalence, associated correlations and regression analyses follow.

5.1.3.1 Stress and Coping Questionnaire Data (shift comparison)

Mean (± SD) perception of stress and coping style prevalence for police officers working a day shift (n=148) or night shift (n=107) are provided in Table 5.8. Independent sample t-tests performed found officers working during the day had a significantly higher mean perception of stress (p=0.017), as well as more prevalent usage of Self-Controlling (p=0.012), Accepting Responsibility (p=0.040) and Escape-Avoidance (p=0.024) coping styles than their night-shift working peers. Both groups perception of stress (LAQ Part 2) scores were below the normative threshold value suggested by Craig and colleagues (1996).

Table 5.8 – Mean perception of stress and coping style prevalence for police officers working a day (n=148) or night shift (n=107)

Variables	**Day (n=148)**	**Night (n=107)**
Perception of Stress (LAQ Part 2)*	16.64 ± 9.39	13.85 ± 8.86
Coping Style	**Prevalence (Percentage)**	
Confrontive Coping	11.41	11.59
Distancing	11.95	12.81
Self-Controlling*	13.79	13.14
Seeking Social Support	13.48	13.75
Accepting Responsibility*	12.41	11.6
Escape-Avoidance*	10.86	9.99
Planful Problem-Solving	15.23	15.59
Positive Reappraisal	10.87	11.45

Table 5.8 shows mean perception of stress and coping style prevalence for the general duties police officers working a day or night shift (n=148 and n=107 respectively). The maximum score for the LAQ Part 2 (perception of stress) is 75, with greater scores indicating a greater perception of stress (Craig et al., 1996). Coping style prevalence describes the proportion of effort represented for each type of coping, with higher relative scores indicating a greater employment of certain coping styles over others as a percentage (Folkman et al., 1986).

Key: LAQ = Lifestyle Appraisal Questionnaire, WCQR = Ways of Coping Questionnaire Revised; n=Sample size, * = Level of statistical significance ($p<0.05$)

5.1.3.2 Stress and Coping Associations & Regression Analyses (shift comparison)

Pearson's correlations were performed to identify the relationship between police officers' perception of stress (LAQ Part 2) and other independent variables depending on working a day or night shift. Where three or more independent variables were found to be significantly correlated with the dependant variable of stress perception, consequent multiple regressions were performed.

Perception of stress was found to have a number of significant relationships with other independent variables when comparing between the shifts (Table 5.9). While officers working during the night's perception of stress was positively correlated to lifestyle risk factors (LAQ Part 1) ($r=0.41$, $p<0.001$) and Escape-Avoidance coping style prevalence ($r=0.26$, $p=0.041$), day-shift working officers' was negatively associated with their age ($r=-0.18$, $p=0.033$). Further, officers working during the day's perception of stress was also positively associated with lifestyle risk factors (LAQ Part 1) ($r=0.27$, $p=0.001$) and the following coping styles' prevalence; Confrontive Coping ($r=0.26$, $p=0.010$), Distancing ($r=0.38$, $p<0.001$), Self-Controlling ($r=0.31$, $p=0.002$), Accepting Responsibility ($r=0.26$, $p=0.009$) and Escape-Avoidance ($r=0.55$, $p<0.001$). A subsequent multiple regression (Table 5.10) was performed using the significant correlations identified and was found to be overall significant for perception of stress ($F(7,91) = 8.04$, $p<0.001$). Together the independent variables explain 38% of the variance in day-shift working officers' stress perception, with lifestyle risk factors ($p=0.005$) and Escape-Avoidance prevalence ($p<0.001$) being the significant predictors.

Table 5.9 – Significant correlations between independent variables and perception of stress for police officers working a day (n=148) or night shift (n=107)

Independent Variables	Perception of Stress (LAQ Part 2)			
	Day (n=148)		Night (n=107)	
	r	*p*	*r*	*p*
Years of Service	-0.18	**0.033**	-	-
Lifestyle Risk Factors (LAQ Part 1)	0.27	**0.001**	0.41	**<0.001**
Confrontive Coping (WCQR1)	0.26	**0.010**	-	-
Distancing (WCQR2)	0.38	**<0.001**	-	-
Self-Controlling (WCQR3)	0.31	**0.002**	-	-
Accepting Responsibility (WCQR5)	0.26	**0.009**	-	-
Escape-Avoidance (WCQR6)	0.55	**<0.001**	0.26	**0.041**

Table 5.9 shows significant results from Pearson's correlations between perception of stress (LAQ Part 2) and other independent variables for the police officers working a day (n=148) or night shift (n=107).

Key: LAQ = Lifestyle Appraisal Questionnaire, WCQR = Ways of Coping Questionnaire Revised; n=Sample size, p = Level of statistical significance (p=<0.05 (in bold))

Table 5.10 – Multiple regression between perception of stress and significantly correlated variables in police officers working a day shift (n=148)

Day (n=148)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Perception of Stress	0.62	0.38	0.36	7.66	**<0.001**
	B	**Std. Error**	**Beta**	**T**	**p**
(Constant)	-2.43	3.98		-0.61	0.54
Years of Service	-0.10	0.12	-0.08	-0.83	0.41
Lifestyle Risk Factors (LAQ Part 1)	0.44	0.15	0.26	2.88	**0.005**
Confrontive Coping (WCQR1)	-0.41	0.31	-0.15	-1.31	0.19
Distancing (WCQR2)	0.05	0.33	0.02	0.14	0.89
Self-Controlling (WCQR3)	0.28	0.29	0.12	0.99	0.33
Accepting Responsibility (WCQR5)	-0.02	0.31	-0.01	-0.06	0.95
Escape-Avoidance (WCQR6)	1.01	0.24	0.54	4.26	**<0.001**

Table 5.6 shows multiple regression analysis between perception of stress (LAQ Part 2) and significant variables as determined by Pearson's correlations; lifestyle risk factors (LAQ Part 1), Confrontive Coping, Distancing, Self-Controlling, Accepting Responsibility and Escape-Avoidance coping style prevalence for the male general duties police officers (n=179).

Key: LAQ = Lifestyle Appraisal Questionnaire, WCQR = Ways of Coping Questionnaire Revised; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

5.1.4 Results: Stress, Coping and Shift Work (rank comparison)

This section presents the results in the context of comparing the general duties police officers based on their rank; 57 were probationary constables (PC) (<1 year service), 99 were constables (C), 53 were senior constables (SC) and 46 were sergeants (Sgt) comprising the total sample (N=255). Their perception of stress and coping style prevalence, associated correlations and regression analyses follow.

5.1.4.1 Stress and Coping Questionnaire Data (rank comparison)

Mean (± SD) perception of stress and coping style prevalence for PC (n=57), C (n=99), SC (n=53) and Sgt (n=46) are provided in Table 5.11. All groups' perception of stress (LAQ Part 2) scores were below the normative threshold value suggested by Craig and colleagues (1996). Analysis of Variance (ANOVA) was performed to determine whether the stress and coping variables recorded differed between ranks (Table 5.12), with a Tukey post-hoc used to identify where the differences lay if statistically significant. Only coping style prevalence (WCQR) was found to differ significantly between ranks, including Seeking Social Support, (p=0.004) with Sgt employing it less than PC (p=0.023) and C (p=0.005), and Positive Reappraisal (p=0.005), again with Sgt employing it less than PC (p=0.003). Further, Accepting Responsibility (p=0.001) was also found to significantly differ, with PC utilising it more often than C (p=0.024), SC (p=0.009) and Sgt (p=0.002). Finally, Escape-Avoidance coping style (p=0.009) was significantly different between ranks, with C using it more prevalently than SC (p=0.030), while this difference was also trending towards significance for Sgt (p=0.06).

Table 5.11 – Mean perception of stress and coping style prevalence for probationary constables (n=57), constables (n=99), senior constables (n=53) and sergeants (n=46)

Variables	PC (n=57)	C (n=99)	SC (n=53)	Sgt (n=46)
Perception of Stress (LAQ Part 2)	14.96 ± 7.41	17.22 ± 10.39	14.74 ± 9.69	13.17 ± 7.67
Coping Style	**Prevalence (Percentage)**			
Confrontive Coping	10.93	11.76	11.42	11.71
Distancing	12.15	12.26	12.32	12.24
Self-Controlling	13.18	13.24	13.60	14.86
Seeking Social Support*	13.34	14.16	13.42	12.73
Accepting Responsibility*	13.55	11.65	11.56	11.46
Escape-Avoidance*	10.37	11.19	9.82	10.01
Planful Problem-Solving	14.79	14.83	16.64	16.47
Positive Reappraisal*	11.59	10.90	11.22	10.53

Table 5.11 shows mean perception of stress and coping style prevalence for the PC, C, SC and Sgt (n=7, n=99, n=53 and n=46 respectively). The maximum score for the LAQ Part 2 (perception of stress) is 75, with greater scores indicating a greater perception of stress (Craig et al., 1996). Coping style prevalence describes the proportion of effort represented for each type of coping, with higher relative scores indicating a greater employment of certain coping styles over others as a percentage (Folkman et al., 1986).

Key: C = Constable, LAQ = Lifestyle Appraisal Questionnaire, PC = Probationary Constable, SC = Senior Constable, Sgt = Sergeant, WCQR = Ways of Coping Questionnaire Revised; n=Sample size, * = Level of statistical significance ($p<0.05$)

Table 5.12 – Significant differences in stress and coping variables for probationary constables (n=57), constables (n=99), senior constables (n=53) and sergeants (n=46)

Variables	p (ANOVA)	Location of difference	p (Tukey HSD test)
LAQ P2	-	-	-
WCQR1CC	-	-	-
WCQR2D	-	-	-
WCQR3SC	-	-	-
WCQR4SSS	**0.004**	1 vs. 4	**0.023**
		2 vs. 4	**0.005**
WCQR5AR	**0.001**	1 vs. 2	**0.024**
		1 vs. 3	**0.009**
		1 vs. 4	**0.002**
WCQR6EA	**0.009**	2 vs. 3	**0.030**
		2 vs. 4	0.06
WCQR7PPS	-	-	-
WCQR8PR	**0.005**	1 vs. 4	**0.003**

Table 5.12 summarises significant differences between the general duties police officers based on their rank. ANOVA was used and where significant a Tukey HSD post-hoc was performed to identify the location of the differences. Seeking Social Support, Accepting Responsibility, Escape-Avoidance and Positive Reappraisal coping style prevalence were found to significantly differ between PC (n=57), C (n=99), SC (n=53) and Sgt (n=46).

Key: ANOVA = Analysis of Variance, C = Constable, HSD = Honestly Significant Difference, LAQ = Lifestyle Appraisal Questionnaire, PC = Probationary Constable, SC = Senior Constable, Sgt = Sergeant, WCQR = Ways of Coping Questionnaire; n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), - = Not significant

5.1.4.2 Stress and Coping Associations & Regression Analyses (rank comparison)

Pearson's correlations were performed to identify the relationship between police officers' perception of stress (LAQ Part 2) and other independent variables depending on their rank. Where three or more independent variables were found to be significantly correlated with the dependant variable of stress perception, consequent multiple regressions were performed.

Perception of stress was found to have a number of significant relationships with other independent variables when comparing between the ranks (Table 5.13). SC stress perception was positively correlated with lifestyle risk factors (LAQ Part 1) ($r=0.38$, $p=0.006$) and Distancing ($r=0.55$, $p=0.003$), while Sgt perception of stress was also positively associated with lifestyle risk factors ($r=0.36$, $p=0.016$) and total travel work time (TTW) ($r=0.50$, $p=0.006$). As such, no regressions were performed for SC or Sgt ranked officers' perception of stress as there were less than three significant independent variables correlated for the ranks.

By comparison, PC stress perception was positively correlated with lifestyle risk factors ($r=0.38$, $p=0.003$) and the following coping styles' prevalence; Confrontive Coping ($r=0.37$, $p=0.021$), Self-Controlling ($r=0.36$, $p=0.022$) and Escape-Avoidance ($r=0.64$, $p<0.001$). A subsequent multiple regression (Table 5.14) was performed using the significant correlations identified and was found to be overall significant for perception of stress ($F(4,35) = 7.23$, $p<0.001$). Together the independent variables explain 45% of the variance in PC ranked officers' perception of stress, with only the covariate of Escape-Avoidance prevalence ($p=0.007$) being a significant predictor.

Finally, C perception of stress was also positively correlated with lifestyle risk factors ($r=0.35$, $p<0.001$) and the following coping styles' prevalence; Self-Controlling ($r=0.30$, $p=0.019$), Accepting Responsibility ($r=0.35$, $p=0.006$) and Escape-Avoidance ($r=0.50$, $p<0.001$). A subsequent multiple regression (Table 5.15) was performed using the significant correlations identified and was found to be overall significant for perception of stress ($F(4,57) = 7.31$, $p<0.001$). Together the independent variables explain 34% of the variance in C ranked officers' stress perception, with lifestyle risk factors ($p=0.012$) and Escape-Avoidance prevalence ($p=0.008$) being the significant predictors.

Table 5.13 – Significant correlations between independent variables and perception of stress for probationary constables (n=57), constables (n=99), senior constables (n=53) and sergeants (n=46)

Independent Variables	Perception of Stress (LAQ Part 2)							
	PC (n=57)		C (n=99)		SC (n=53)		Sgt (n=46)	
	r	***p***	***r***	***p***	***r***	***p***	***R***	***p***
Lifestyle Risk Factors (LAQ Part 1)	0.38	**0.003**	0.35	**<0.001**	0.38	**0.006**	0.36	**0.016**
TTW	-	-	-	-	-	-	0.50	**0.006**
Confrontive Coping (WCQR1)	0.37	**0.021**	-	-	-	-	-	-
Distancing (WCQR2)	-	-	-	-	0.55	**0.003**	-	-
Self-Controlling (WCQR3)	0.36	**0.022**	0.30	**0.019**	-	-	-	-
Accepting Responsibility (WCQR5)	-	-	0.35	**0.006**	-	-	-	-
Escape-Avoidance (WCQR6)	0.64	**<0.001**	0.50	**<0.001**	-	-	-	-

Table 5.13 shows significant results from Pearson's correlations between perception of stress (LAQ Part 2) and other independent variables for the PC, C, SC and Sgt (n=7, n=99, n=53 and n=46 respectively).

Key: C = Constable, LAQ = Lifestyle Appraisal Questionnaire, PC = Probationary Constable, SC = Senior Constable, Sgt = Sergeant, WCQR = Ways of Coping Questionnaire Revised; n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), - = Not significant

Table 5.14 – Multiple regression between perception of stress and significantly correlated variables in probationary constables (n=57)

PC (n=57)	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**p**
Perception of Stress	0.67	0.45	0.39	5.79	**<0.001**
	B	**Std. Error**	**Beta**	**T**	**p**
(Constant)	-0.30	4.71		-0.06	0.95
Lifestyle Risk Factors (LAQ Part 1)	0.29	0.19	0.21	1.50	0.14
Confrontive Coping (WCQR1)	-0.09	0.42	-0.04	-0.21	0.83
Self-Controlling (WCQR3)	0.08	0.31	0.04	0.25	0.80
Escape-Avoidance (WCQR6)	0.85	0.29	0.58	2.89	**0.007**

Table 5.14 shows multiple regression analysis between perception of stress (LAQ Part 2) and significant variables as determined by Pearson's correlations; lifestyle risk factors (LAQ Part 1), Confrontive Coping, Self-Controlling and Escape-Avoidance coping style prevalence for the probationary constables (n=57).

Key: LAQ = Lifestyle Appraisal Questionnaire, PC = Probationary Constable, WCQR = Ways of Coping Questionnaire Revised; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Table 5.15 – Multiple regression between perception of stress and significantly correlated variables in constables (n=99)

C (n=99)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Perception of Stress	0.58	0.34	0.29	8.74	**<0.001**
	B	**Std. Error**	**Beta**	**T**	**p**
(Constant)	-2.95	4.62		-0.64	0.53
Lifestyle Risk Factors (LAQ Part 1)	0.56	0.21	0.29	2.59	**0.012**
Self-Controlling (WCQR3)	-0.32	0.35	-0.13	-0.91	0.37
Accepting Responsibility (WCQR5)	0.87	0.53	0.22	1.64	0.11
Escape-Avoidance (WCQR6)	0.83	0.30	0.41	2.74	**0.008**

Table 5.15 shows multiple regression analysis between perception of stress (LAQ Part 2) and significant variables as determined by Pearson's correlations; lifestyle risk factors (LAQ Part 1), Self-Controlling, Accepting Responsibility and Escape-Avoidance coping style prevalence for the constables (n=99).

Key: C = Constable, LAQ = Lifestyle Appraisal Questionnaire, WCQR = Ways of Coping Questionnaire Revised; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

5.2 Discussion: Stress, Coping and Shift Work

This chapter discusses findings with respect to perception of stress, coping and shift work. It examines the significant relationships, before also addressing the differences between the identified comparative groups of sex (males vs. females), shift (day vs. night) and occupational rank (probationary constables, constables, senior constables and sergeants).

5.2.1 Stress, Coping and Shift Work (total sample)

In the total sample of general duties police officers assessed, their mean perception of stress score (LAQ Part 2) was found to be below the normative threshold score (shown in Table 5.16) for their age bracket (Craig et al., 1996). Only 32% of the population were found to have high perceptions of stress; while a moderate proportion, this conflicts with the romanticised notion that policing is inherently stressful (Perrier & Toner, 1984; Shane, 2010). Studies have cited severe levels of stress predominating in their populations of police officers (Sigler & Wilson, 1988; Anderson et al., 2002; Husain et al., 2014; Luceno-Moreno et al., 2016), attributable to a series of occupational hazards including responding to critical incidents (Arnsten, 1998), physical assaults and excessive work demands (Lawrence, 1984; Bano & Talib, 2014), as well as issues indirectly associated with policing, like dealing with a non-supportive public and antagonistic media (Perrier & Toner, 1984; Finn, 1997). The risk of accidents and injury in the line of duty are also concerning (Violanti et al., 2012), often resulting in a depersonalisation or authoritarian attitudes to develop within the police force (Violanti & Marshall, 1983). Chronic occupational stressors and the incidence of PTSD among police populations, though not assessed in this cohort, has also been shown to have adverse physiological effects on the body (Axelrod & Reisine, 1984; Loo, 1984), including depression of the immune system and alterations in hippocampal volume (Lindauer et al., 2004; Lindauer et al., 2006).

Table 5.16 – Normative data for Part 2 of the Lifestyle Appraisal Questionnaire

Sex	Perception of Stress (LAQ Part 2)					
	Group 1			Group 2		
	Age	n	Mean (SD)	Age	n	Mean (SD)
Males	< 30	131	19.4 (9.7)	< 30	10	24.6 (5.7)
	30 - 50	86	18.8 (9.3)	30 - 50	50	24.1 (12.9)
	> 50	63	17.1 (10.7)	> 50	10	18.9 (11.1)
Females	< 30	139	20.9 (9.7)	< 30	16	22.8 (11.1)
	30 - 50	126	21.3 (10.9)	30 - 50	48	23.4 (11.1)
	> 50	55	18.0 (10.7)	> 50	9	19.2 (7.11)

Table 5.16 shows the normative scores for Part 2 of the LAQ. Group 1 consisted of randomly selected members of a local community, while Group 2 was a sample of randomly selected university staff. Both groups provide adult norms, with scores distributed by age and sex. Adapted from (Craig et al., 1996), page 338.

Key: LAQ = Lifestyle Appraisal Questionnaire; n=Sample size, SD = Standard Deviation

However, the findings of this study may conform to a growing body of research which suggests that the majority of police officers do not experience excessive stress. Although utilising different measures of subjective stress, more recent studies have found similar prevalence of higher stress perception to be in the minority of their police officer samples (Kaur et al., 2013; Masilamani et al., 2013; Alexopoulos et al., 2014; Acquadro-Maran et al., 2015). Some authors even suggest police officers are no more stressed than comparable occupations (Anson & Bloom, 1988; Johnson et al., 2005), or even the general public (Deschamps et al., 2003); however the consequences of police officers failing to cope with stress has a far greater effect on the wider community (Webb & Smith, 1980). Researchers have begun suggesting it is not simply the hazards of policing which should be a concern, but the organisational stressors (Collins & Gibbs, 2003; Bano & Talib, 2014), including shift work.

While the LAQ is a validated and reliable measure of subjective stress perception (Craig et al., 1996), this study did not explicitly assess the police officers' sources of stress. Organisational stressors have been suggested to be a greater burden on police officers' mental and physical health than traditional occupational hazards (Collins & Gibbs, 2003). Factors within the organisational structure and climate of policing are believed to precipitate stress (Anson & Bloom, 1988; Shane, 2010), including insufficient personnel, inadequate training, difficult promotion processes and administrative bureaucracy (Brown & Campbell, 1990; Kirkcaldy et al., 1995). The 'job strain' model proposed by Karasek (1979) offers insight; the combination of low decision latitude and high work load in policing results in excessive mental strain. Shift work is also often cited as the greatest source of organisational stress among police officers (Violanti & Aron, 1994), due to the time pressures applied to social and filial obligations (Harrington, 2001; Costa, 2003; Loudoun, 2008), as well as the established impact on natural sleep/wake cycle (Åkerstedt & Wright, 2009; Costa, 2015). Despite the overwhelming evidence of the detrimental effects of shift work on stress and sleep health (Neylan et al., 2002; Gerber, Hartmann, et al., 2010), it is a necessity in our modern world; as such, research must investigate police officers' use of suitable coping mechanisms to deal with the intrinsic stressors of their occupation.

Within this sample of general duties police officers more favourable coping mechanisms predominated (such as Planful-Problem Solving and Seeking Social Support), while the less desirable styles of Distancing and Escape-Avoidance were less frequently employed (visualised in Figure 5.2). The ability to cope with persistent sources of stress is imperative (Lazarus & Folkman, 1984), and the prevalence of approach-based behavioural coping (Anshel, 2000) among this cohort may be responsible for the relatively low proportion of officers with high stress perception. These findings conform to available literature regarding police officers' preference for more problem-focused coping (Evans et al., 1993; Beehr et al., 1995; Biggam et al., 1997; Kaur et al., 2013; Balmer et al., 2014; Stępka & Basinska, 2014), which has been found to be more efficacious in dealing with uncontrollable, chronic stressors like shift work (Suls & Fletcher, 1985; Roth & Cohen, 1986). Coping style prevalence has also been found to differ between police forces based on the country assessed (Morash, Lee, et al., 2006; Adole et al., 2015), and is likely to be due to ingrained cultural differences (Terpstra & Schaap, 2013). While not assessed in this study, hardiness has also been proposed as a personality trait that assists coping behaviours (Kobasa, 1979; Kobasa et al., 1982), however the results in the literature are mixed (McCranie et al., 1987; Tang & Hammontree, 1992; Anshel, 2000). Although some studies have found a reliance on alcohol and smoking as an avoidance coping mechanism among police officers (Violanti et al., 1985; Alexander & Wells, 1991; Richmond et al., 1998), this was not found to predominate among this cohort. However, this may have been screened out by the selection criteria of this study addressing excessive smoking and alcohol consumption (Craig et al., 1996), thereby underestimating the magnitude via survival bias of less effective coping styles (Gershon et al., 2009; Menard & Arter, 2014). Failure to cope with stressors, both occupational and organisational, has negative repercussions for both the individual and the police organisation (Aldwin & Revenson, 1987; Meerlo et al., 2008; Violanti et al., 2012). Utilization of less desirable coping styles has been associated with distress (Acquadro-Maran et al., 2015), and is reflected in the significant associations found between less adaptive coping styles and police officers' perception of stress in this sample. Further, the inverse relationship between stress perception and years of service supports the notion that officers with more experience of policing are more likely to cope with stressors and excel in their occupation (Patterson, 2000). A strength of this study was the field-based nature to explore police officers' coping style preference under their regular shift system, compared to other research which examined acute, irregular stress events to assess police coping (McCammon et al., 1988; Alexander & Wells, 1991).

Figure 5.2 – Visualisation of the most to least prevalent coping styles in general duties police officers (N=255)

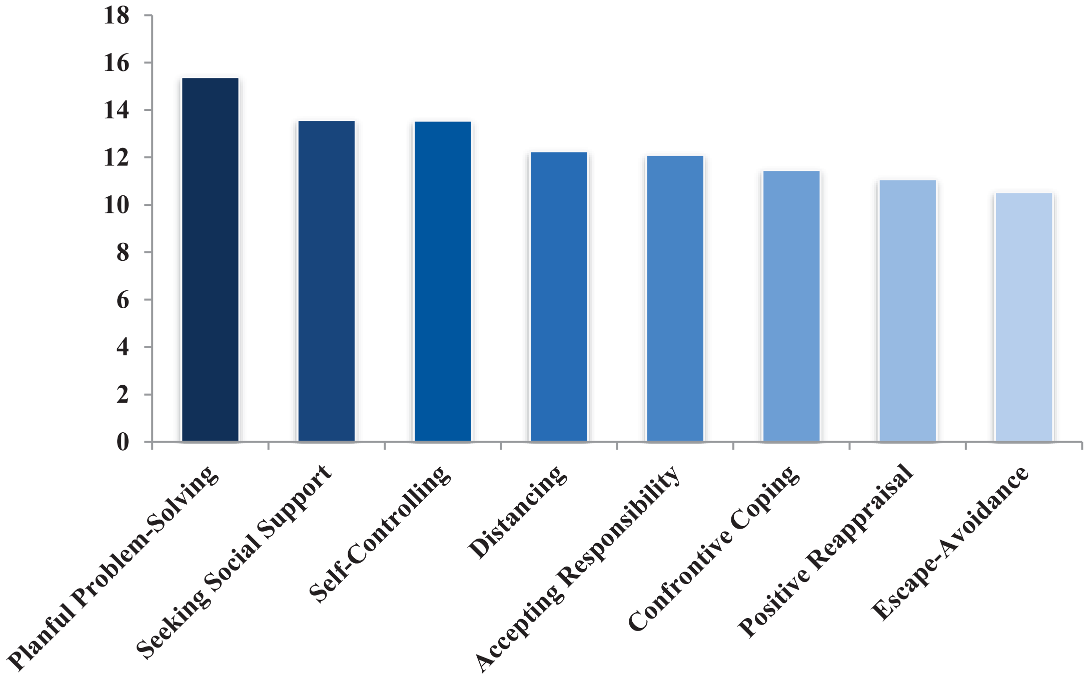

Figure 5.2 summarises the coping styles as assessed by the WCQR (Folkman et al., 1986) for general duties police officers (N=255), ordered from most to least prevalent.

Key: WCQR = Ways of Coping Questionnaire Revised

Police officers employed under shift working conditions would benefit from strategies seeking to ameliorate the stressors affecting their occupation. Greater support structures (Finn, 1997), including mentoring programmes with more senior officers (Hassell et al., 2011), have been suggested to improve communication and reduce previously discussed organisational stressors (McCarty et al., 2007). More radical approaches, like redistricting of LAC's, could ratify existing imbalances with respect to work load and call volume (Hickman et al., 2011). The stress-buffering effects of exercise are also well documented and should be encouraged where possible (Gerber, Kellman, et al., 2010; Martins & Lopes, 2013), the added benefit being further countering of the reduced physical activity and increased metabolic risk among shift workers (Antunes et al., 2010; Esquirol et al., 2011). Education and interventional strategies to improve police officers' stress management and coping mechanisms are also recommended (Murphy, 1984; Brown et al., 1996; Bonnar, 2000; Gershon et al., 2009), and should be integrated into training for police recruits (Kaiseler et al., 2014), although some authors contest whether coping is inherent or can be learnt (Bishop et al., 2001). Care must be taken when implementing steps to improve stress and coping among shift working police officers, as allocating additional funding without considering changes to existing sources of stress are unlikely to yield improvements (Shane, 2010). Also, there is an irony that requiring officers to complete additional interventional strategies may further compound their abundant organisational stressors. Although there are novel approaches to forming integrative models of police stress and coping (Webster, 2014), it is essential for research to continue beyond the scope of self-reported measures (Anshel et al., 1997; Anshel, 2000). In this study, the majority of general duties police officers assessed were found to exhibit relatively low levels of stress perception, and this is likely due to the prevalence of preferable coping mechanisms. By dealing effectively with their sources of occupational and organisational stress, members of the NSW Police Force will continue operating under a shift roster system while ensuring their own occupational safety and health.

5.2.2 Stress, Coping and Shift Work (comparisons)

This section focuses on the differences which exist between the established sub-groups of sex (male vs. female), shift (day vs. night) and rank (probationary constable, constable, senior constable and sergeants). As such, the majority of the discussions with respect to stress, coping and shift work already presented will not be repeated again.

5.2.2.1 Stress and Coping: Impact of sex

In this sample of general duties police officers, although perception of stress did not differ significantly based on sex, there were variations in the significant relationships identified. The majority of the associations identified have already been discussed for the total sample, while the inverse relationships between females' perception of stress, age and years of service was to be expected (Kirkcaldy et al., 1998). There is heavy contention in the available literature whether police officers exhibit higher levels of stress depending on their sex; the findings of this study conform to a wealth of research citing no significant difference in the sexes' perception of stress (Hassell et al., 2011; Kaur et al., 2013; Luceno-Moreno et al., 2016). However, within these studies of police officers and similar occupations they note varying responsibilities, exposure to gendered stressors, and differences in the sexes' response to operational and organisational stress (Alexander & Wells, 1991; Brown & Fielding, 1993; Biggam et al., 1997b; Collins & Gibbs, 2003). This was unexpected, based on the established evidence of sexual dimorphism in neural pathways (including the limbic system and HPA axis) (Kudielka & Kirschbaum, 2005), as well as neurohormonal differences between the sexes when responding to acute and chronic stress (Herman & Cullinan, 1997; Kajantie & Phillips, 2006). The majority of research involving stress reflects this in the general population (Matud, 2004; Alvares et al., 2013), and further opposes the findings of this study with respect to police officers' stress.

While some studies have found male police officers to be more stressed (Norvell et al., 1993; Gerber, Hartmann, et al., 2010), it is more common for researchers to report a significantly higher perception of stress among their female police samples (Charles et al., 2011; Bano & Talib, 2014; Acquadro-Maran et al., 2015; Kim et al., 2016a). They propose this is due to a number of factors, including the male-dominated environment of policing (Dowler & Arai, 2008; Haarr & Morash, 2013), incongruities between sex and workplace role expectations (Acquadro-Maran et al., 2014), underestimations of physical ability and self-perception of 'tokenism' (Morash, Kwak, et al., 2006), as well as the greater sensitivity and willingness of females to report stress' impact on their physical and mental health (Husain et al., 2014). Shift work among police officers has also been suggested to discriminate more against females, due to time constraints of expected gender roles of child-rearing and other familial obligations (Antoniou, 2009; Kurtz, 2012; Bezerra et al., 2013). However, the disparities between this study's findings and the available literature may also be due to the adoption and utilisation of different coping mechanisms.

With respect to coping mechanism prevalence, police officers in this study did not differ significantly except for females using more Seeking Social Support and Escape-Avoidance styles. While some authors report similar findings with police officers not differing when comparing between the sexes (Patterson, 2000), the majority suggest coping styles will differ between males and females (He et al., 2005). Greater social support and Escape-Avoidance strategies among female police officers have been noted in similar studies (Biggam et al., 1997; Kirkcaldy et al., 1998; Haarr & Morash, 1999; Acquadro-Maran et al., 2014), however the most common difference appears to be women's utilization of more emotion-focused coping in dealing with police stressors (Matud, 2004; Balmer et al., 2014; Adole et al., 2015). The lack of differences in this sample between police officers' perception of stress when comparing by sex may be justified by the relatively minimal variations in their coping styles. While sex discrimination within Australian police forces has undergone significant improvement (Prenzler & Hayes, 2000; Szalajko, 2005), occupational and organisational stressors persist and are experienced equally by both sexes. Female police officers within this sample may be adopting more traditionally male-associated coping strategies, which could explain how both male and female general duties police officers assessed were found to have relatively low perceptions of stress (Craig et al., 1996). Further research is required to determine how coping mechanisms influence officers' ability to operate under the deleterious effects of shift work while also grappling with the stressors inherent to policing.

5.2.2.2 Stress and Coping: Impact of shift

When comparing within this sample of general duties police officers based on their shift at time of assessment (day or night), although both groups' mean perception of stress was found to be below normative thresholds (Craig et al., 1996), those working during the day were found to have significantly higher scores. Further, they were also found to use significantly more Self-Controlling, Accepting Responsibility and Escape-Avoidance coping strategies compared to their night-shift working peers. Similar to the findings with respect to officers' BP presented in Chapter 4, it is difficult to determine the cause of these disparities. All general duties police officers in NSW are exposed to the same twelve hour, clockwise-oriented, rapidly rotating shift work roster (Achterstraat, 2007); the difficulty lies in that the majority of the literature explores the difference in stress and coping among fixed day and rotating shift workers. Contention exists between authors on whether no significant differences exist (Almondes & Araujo, 2009; Luceno-Moreno et al., 2016), or more often that those working nights/shift working involves an expected increase in stress burden (Lin et al., 2015; Ferri et al., 2016), both physical and mental. The varying associations with perception of stress and coping prevalence among this sample may also be due to more logistical circumstances. For example, crime rates differ by time of day (Felson & Poulsen, 2003; Gottfredson & Soulé, 2004), so the differences observed may come down to which activities were undertaken during the respective day or night shift (Ma et al., 2015; Vasquez-Trespalacios et al., 2016), as well as whether it was their first or second day/night shift in their roster (Ramey et al., 2012), both of which unfortunately were not recorded in this study. Working during the day or night each come with their own respective hazards and stressors, requiring further research into how police officers' perceive and cope with the occupational and organisational pressures within a shift working environment.

5.2.2.3 Stress and Coping: Impact of rank

Comparisons were also made between general duties police officers' perception of stress and coping style based on their occupational rank. Subjects' stress perception did not significantly differ based on their rank, and all mean scores were found to fall below normative thresholds (Craig et al., 1996). Similar findings have been reported amongst police populations (Band & Manuele, 1987; Alexopoulos et al., 2014; Luceno-Moreno et al., 2016), however other studies and logic dictates that police rank should be an influence on their level of stress and coping style (Gundjonsson & Adlam, 1985; Bonnar, 2000; Bano & Talib, 2014). Some studies have reported more senior police officers and military personnel report higher levels of stress (Deschamps et al., 2003; Antoniou, 2009; Martins & Lopes, 2012), due to their greater volume of responsibilities (Masilamani et al., 2013), thereby increasing organisational stressors (Violanti & Aron, 1995; Biggam et al., 1997b; Balmer et al., 2014), as well as alternate expectations of physical activity (Johnson et al., 2005; Martins & Lopes, 2013) and the depreciations in shift work tolerance associated with aging (Gershon et al., 2002; Costa & Di Milia, 2008). However, senior police officers have also often shown a better handling of coping response (Kirkcaldy et al., 1998), due to their greater experience gained over time (Anshel et al., 1997). There is also the potential of survival bias (Gershon et al., 2009), wherein police officers who employ more destructive coping mechanisms are more likely to retire, resign or pass due to natural attrition, allowing those who can better cope with the inherent stressors of policing and shift work to excel and rise in rank. It is interesting that the majority of coping style prevalence did not differ significantly between police ranks in this cohort (Alexander & Wells, 1991; Biggam et al., 1997a; Patterson, 2000; Adole et al., 2015); probationary constables' reliance on more Seeking Social Support, Positive Reappraisal and Accepting Responsibility may be due to changes in training procedures, coping education and screening programmes during recruitment (Balmer et al., 2014). Studies on solely senior police officers' stressors are important (Brown et al., 1996), as their health and wellbeing often dictates the occupational environment and culture far more than junior officers (Steinheider & Wuestewald, 2008; Gultekin, 2014), most likely due to the hierarchical structure of the organisation.

5.3 Conclusion: Stress, Coping and Shift Work

The current study identified a number of significant associations between perception of stress (LAQ Part 2) and independent variables among shift working police officers, as well as differences based on their sex, shift and occupational rank. Relatively minimal numbers of general duties police officers were found to perceive abnormal levels of stress, with the only major difference observed between those working a day or night shift. This conflicts with a lot of available literature suggesting both shift workers and police officers experience excessive stress (Shane, 2010; Manenschijn et al., 2011; Pineles et al., 2013; Husain et al., 2014; Luceno-Moreno et al., 2016), suggesting further investigations are required into the management of organisational and occupational stressors. The greater prevalence of preferable coping style mechanisms (WCQR) within the sample were likely responsible for these favourable findings, although this varied significantly between subgroups, with possible reasons discussed above. Finally, significant correlations were found with perception of stress, where the majority of findings conformed to similar research linking higher stress levels to lifestyle risk factors (LAQ Part 1) and less optimal coping styles. Future research must incorporate more physiological measures of stress, such a blood or salivary cortisol analysis, while also investigating whether coping style prevalence is inherent or learned. The effects of chronic stress on the human body are known, and the NSW Police Force can continue supporting their members by implementing interventional strategies to maintain officer health and wellbeing, while employed under a shift work roster system. Refer to Table 5.17, 5.18, 5.19 and 5.20 for a summary of the significant associations between perception of stress and independent variables for each sample.

Table 5.17 – Summary of significant partial correlations between perception of stress and independent variables for the total sample (N=255)

	Independent Variables	Perception of Stress
Total Sample (N=255)	Years of Service	-
	Lifestyle Risk Factors (LAQ Part 1)	+
	Confrontive Coping (WCQR1)	+
	Distancing (WCQR2)	+
	Self-Controlling (WCQR3)	+
	Accepting Responsibility (WCQR5)	+
	Escape-Avoidance (WCQR6)	+

Table 5.17 summarises the significant Pearson's correlations between perception of stress and other variables from the LAQ and WCQR for the total sample (N=255).

Key: LAQ = Lifestyle Appraisal Questionnaire, WCQR = Ways of Coping Questionnaire Revised; + = Positive correlation; - = Negative correlation

Table 5.18 – Summary of significant partial correlations between perception of stress and independent variables for male (n=179) and female (n=76) police officers

Male (n=179) vs. Female (n=76) Police Officers	Independent Variables	Perception of Stress
	Years of Age	-
	Years of Service	-
	Lifestyle Risk Factors (LAQ Part 1)	+
	Confrontive Coping (WCQR1)	+
	Distancing (WCQR2)	+
	Self-Controlling (WCQR3)	+
	Accepting Responsibility (WCQR5)	+
	Escape-Avoidance (WCQR6)	+ / +

Table 5.18 summarises the significant Pearson's correlations between perception of stress and other variables from the LAQ and WCQR for the male (shown in black) (n=179) and female (shown in red) police officers.

Key: LAQ = Lifestyle Appraisal Questionnaire, WCQR = Ways of Coping Questionnaire Revised; + = Positive correlation; - = Negative correlation

Table 5.19 – Summary of significant partial correlations between perception of stress and independent variables for police officers working a day (n=148) or night shift (n=107)

Day (n=148) vs. Night Shift (n=107) Police Officers	Independent Variables	Perception of Stress
	Years of Service	-
	Lifestyle Risk Factors (LAQ Part 1)	+ / +
	Confrontive Coping (WCQR1)	+
	Distancing (WCQR2)	+
	Self-Controlling (WCQR3)	+
	Accepting Responsibility (WCQR5)	+
	Escape-Avoidance (WCQR6)	+ / +

Table 5.19 summarises the significant Pearson's correlations between perception of stress and other variables from the LAQ and WCQR for the day (shown in black) (n=148) and night shift (shown in red) (n=107) police officers.

Key: LAQ = Lifestyle Appraisal Questionnaire, WCQR = Ways of Coping Questionnaire Revised; + = Positive correlation; - = Negative correlation

Table 5.20 – Summary of significant partial correlations between perception of stress and independent variables for probationary constables (n=57), constables (n=99), senior constables (n=53) and sergeants (n=46)

Probationary Constables (n=57), Constables (n=99), Senior Constables (n=53) vs. Sergeants (n=46)	Independent Variables	Perception of Stress
	Lifestyle Risk Factors (LAQ Part 1)	+ / + / + / +
	TTW	+
	Confrontive Coping (WCQR1)	+
	Distancing (WCQR2)	+
	Self-Controlling (WCQR3)	+ / +
	Accepting Responsibility (WCQR5)	+
	Escape-Avoidance (WCQR6)	+ / +

Table 5.20 summarises the significant Pearson's correlations between perception of stress and other variables from the LAQ and WCQR for PC (shown in black) (n=57), C (shown in red) (n=99), SC (shown in green) (n=53) and Sgt (shown in blue) (n=46).

Key: LAQ = Lifestyle Appraisal Questionnaire, TTW = Total Travel Work Time, WCQR = Ways of Coping Questionnaire Revised; + = Positive correlation; - = Negative correlation

Chapter 6 Sleep and Shift Work

6.1 Results: Sleep and Shift Work

A total of 225 police officers were recruited for the present study which, after selection criteria was applied (Section 3.3), provided an inclusive sample of 159 (Table 3.1 in Section 3.3 details subjects' reasons for exclusion). These participants were added to an existing data base of police officers, obtained using a similar experimental protocol conducted by this researcher and the Neuroscience Research Unit of the University of Technology Sydney (UTS) (Elliott & Lal, 2016).

This chapter reports the total samples' (N=255) sleep quality, fatigue and sleepiness information, before presenting Pearson's correlations and subsequent multiple regressions (detailed in Section 3.6) to determine the prevalence and relationships involving a variety of sleep factors and other variables. Finally, further descriptive statistics, associations and comparisons are determined and compared within four distinct sample populations; males (n=179) vs. females (n=76), day (n=148) vs. night shift (n=107) and rank (probationary constable, constable, senior constable and sergeant; n=57, 99, 53 and 46 respectively).

6.1.1 Results: Sleep and Shift Work (total sample)

This section presents the results in the context of the total sample (N=255). Their sleep quality, fatigue and sleepiness prevalence, with associated correlations and regression analyses, follow.

6.1.1.1 Sleep Questionnaire Data (total sample)

Mean (± SD) quality of sleep, fatigue and sleepiness prevalence is provided for the total sample (N=255). Overall quality of sleep was determined by the Pittsburgh Sleep Quality Index (PSQI) (Table 6.1), by adding values drawn from seven component scores that assess different aspects of sleep, including subjective sleep quality, sleep onset latency, sleep duration, sleep efficiency, sleep disturbances, sleep medication usage and daytime dysfunction. The component scores range from 0 – 3, with the global PSQI score having a maximum value of 21 with higher scores indicating a worse quality of sleep. The mean overall sleep quality score (PSQI) of 6.76 ± 3.59 was above the normative threshold value (>5.00) as provided by Buysse and colleagues (1989). Figure 6.1 shows the distribution of overall sleep quality (PSQI) scores for the total sample, with 69% of police officers scoring greater than the normative threshold value (Buysse et al., 1989).

Table 6.1 – Mean overall sleep quality for the total sample (N=255)

Total sample (N=255)	Global PSQI Score	Mean ± SD
	Overall Sleep Quality	6.76 ± 3.59
	Sleep Component	**Mean ± SD**
	Subjective Sleep Quality (PSQIC1)	1.23 ± 0.79
	Sleep Onset Latency (PSQIC2)	1.35 ± 0.98
	Sleep Duration (PSQIC3)	0.92 ± 0.93
	Sleep Efficiency (PSQIC4)	0.72 ± 0.98
	Sleep Disturbances (PSQIC5)	1.25 ± 0.54
	Sleep Medication Usage (PSQIC6)	0.25 ± 0.66
	Daytime Dysfunction (PSQIC7)	1.04 ± 0.83

Table 6.1 shows mean overall sleep quality for the total sample of general duties police officers (N=255). The maximum score for the PSQI (overall sleep quality) is 21, with greater scores indicating a worse quality of sleep (Buysse et al., 1989). The global score is determined by summing the seven component values, which assess different facets of sleep, including subjective sleep quality, sleep onset latency, sleep duration, sleep efficiency, sleep disturbances, sleep medication usage and daytime dysfunction.

Key: PSQIC = Pittsburgh Sleep Quality Index Component; SD =Standard Deviation, ± = Plus and minus

Figure 6.1 – Frequency distribution of the overall sleep quality for the total sample (N=255)

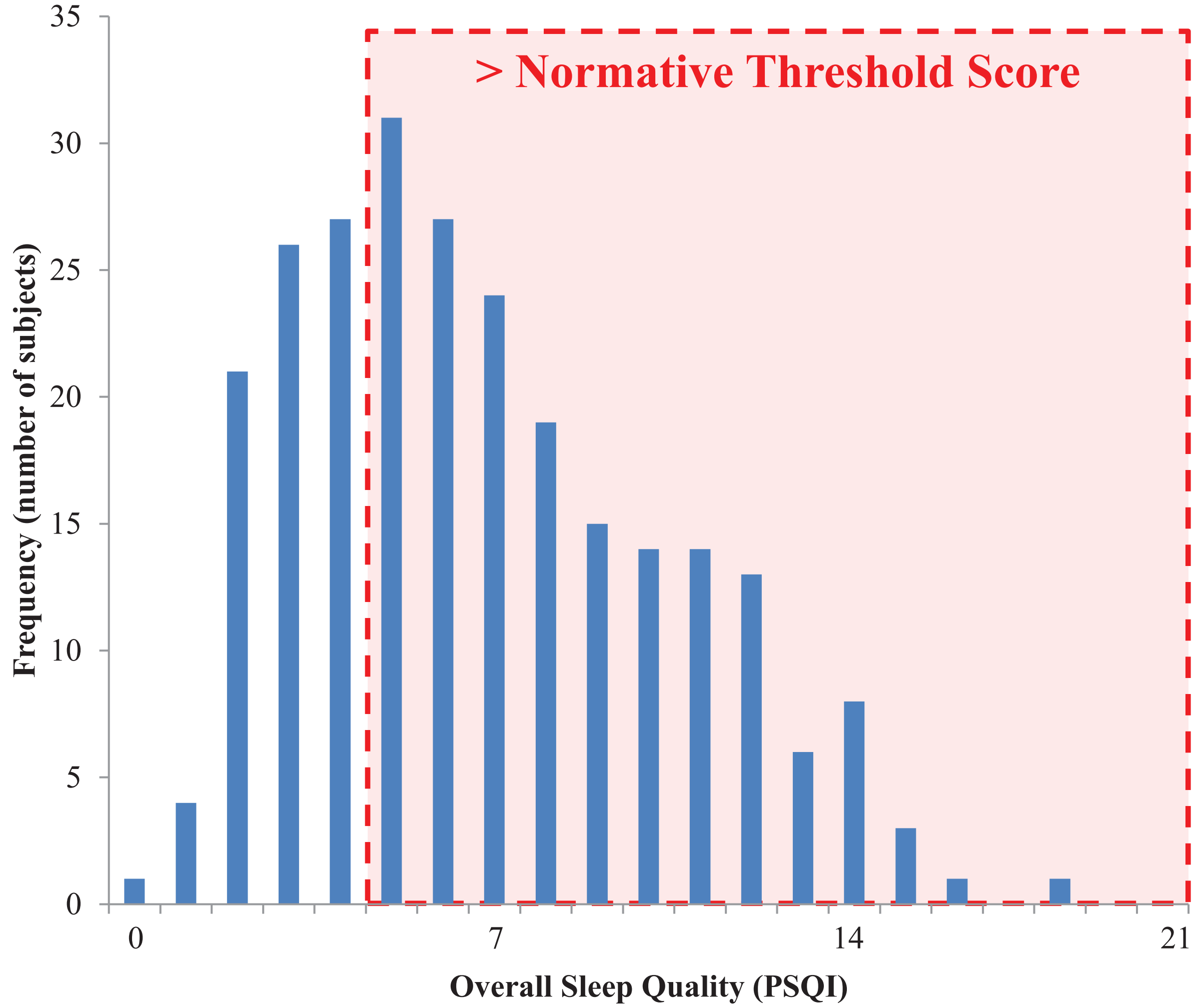

Figure 6.1 depicts the overall sleep quality (PSQI) scores for the total sample of general duties police officers (N=255). The histogram shows that the majority of subjects were scoring above the normative threshold score of 5.00, indicating poor sleep quality (Buysse et al., 1989).

Key: PSQI = Pittsburgh Sleep Quality Index

Sleepiness and fatigue prevalence were also assessed for the general duties police officers (Table 6.2). Sleepiness risk was determined by the Epworth Sleepiness Scale (ESS), by adding values attributed to selectable criteria with a maximum potential score of 24 (Johns, 1991). The mean sleepiness risk score (ESS) of 6.94 ± 4.09 was below the normative threshold value (≤9) as provided by Johns (1991). Figure 6.2 shows the distribution of sleepiness risk (ESS) scores for the total sample, with 25% of police officers scoring greater than the normative threshold value indicating excessive sleepiness.

Fatigue severity was determined by the Fatigue Severity Scale (FSS), by adding values attributed to selectable criteria with a maximum potential score of 63 (Krupp et al., 1989). The mean fatigue severity score (FSS) of 35.14 ± 10.40 was almost equal with the normative threshold value (≥36) as provided by Krupp and colleagues (1989). Figure 6.3 shows the distribution of fatigue severity (FSS) scores for the total sample, with 49% of police officers scoring greater than the normative threshold value indicating a greater intensity of fatigue.

Finally, Checklist of Individual Strength (CIS20) was also administered to determine different aspects of fatigue, specifically subjective fatigue and reduced concentration, motivation and activity (Vercoulen et al., 1994). While the mean total CIS20 score (fatigue impact) of 63.35 ± 19.57 was below the threshold value (>76) suggested by Bültmann and colleagues (2000), the subjects' mean subjective fatigue (CIS20-1) component score of 27.91 ± 10.06 was above the normative threshold value (≥27) offered by the original authors (Vercoulen et al., 1994). Figure 6.4 shows the distribution of subjective fatigue (CIS20-1) scores for the total sample, indicating an elevated or severe perception of fatigue.

Table 6.2 – Mean sleepiness and fatigue scores for the total sample (N=255)

	Variable	Mean ± SD
Total sample (N=255)	Sleepiness Risk (ESS)	6.94 ± 4.09
	Fatigue Severity (FSS)	35.14 ± 10.40
	Total Fatigue Impact (CIS20)	63.35 ± 19.57
	CIS20 Component	**Mean ± SD**
	Subjective Fatigue (CIS20-1)	27.91 ± 10.06
	Reduced Concentration (CIS20-2)	15.67 ± 5.72
	Reduced Motivation (CIS20-3)	11.87 ± 4.16
	Reduced Activity (CIS20-4)	7.90 ± 3.64

Table 6.2 shows mean sleepiness risk, fatigue severity and total fatigue for the total sample of general duties police officers (N=255). The maximum score for the ESS (sleepiness risk) is 24, with greater scores indicating a greater likelihood of dozing (Johns, 1991). The maximum score for the FSS (fatigue severity) is 63, with greater scores indicating a stronger severity of fatigue impact (Krupp et al., 1989). The maximum score for the CIS20 is determined by summing the four component values, which assess different aspects of fatigue, including subjective fatigue and reduced concentration, motivation and activity (Vercoulen et al., 1994).

Key: CIS20 = Checklist of Individual Strength, ESS = Epworth Sleepiness Scale, FSS = Fatigue Severity Scale; SD = Standard Deviation, ± = Plus and minus

Figure 6.2 – Frequency distribution of sleepiness risk for the total sample (N=255)

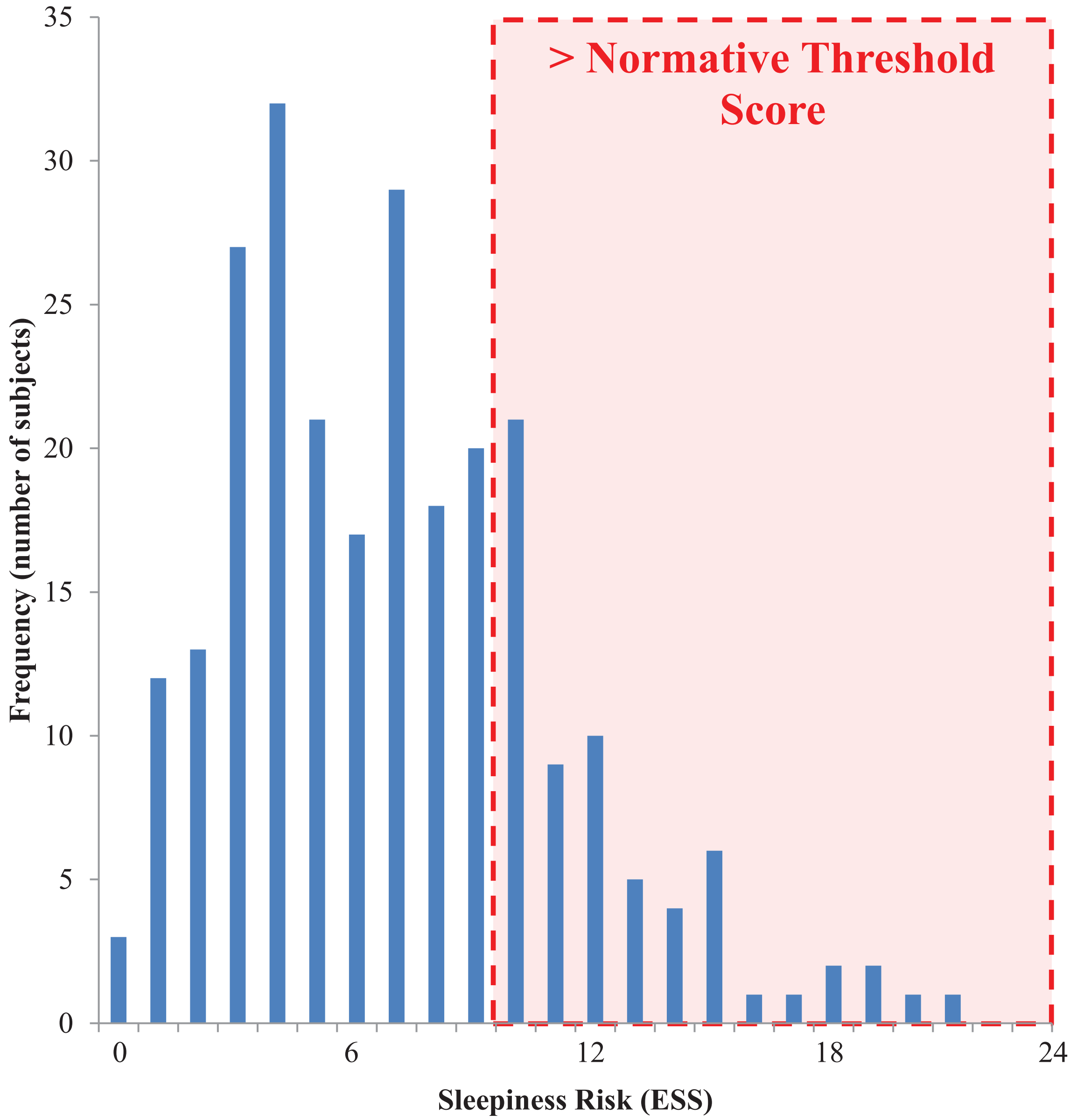

Figure 6.2 depicts the sleepiness risk (ESS) scores for the total sample of general duties police officers (N=255). The histogram shows that the majority of subjects were scoring below the normative threshold score of 10, indicating low or normal levels of sleepiness (Johns, 1991).

Key: ESS = Epworth Sleepiness Scale

Figure 6.3 – Frequency distribution of fatigue severity for the total sample (N=255)

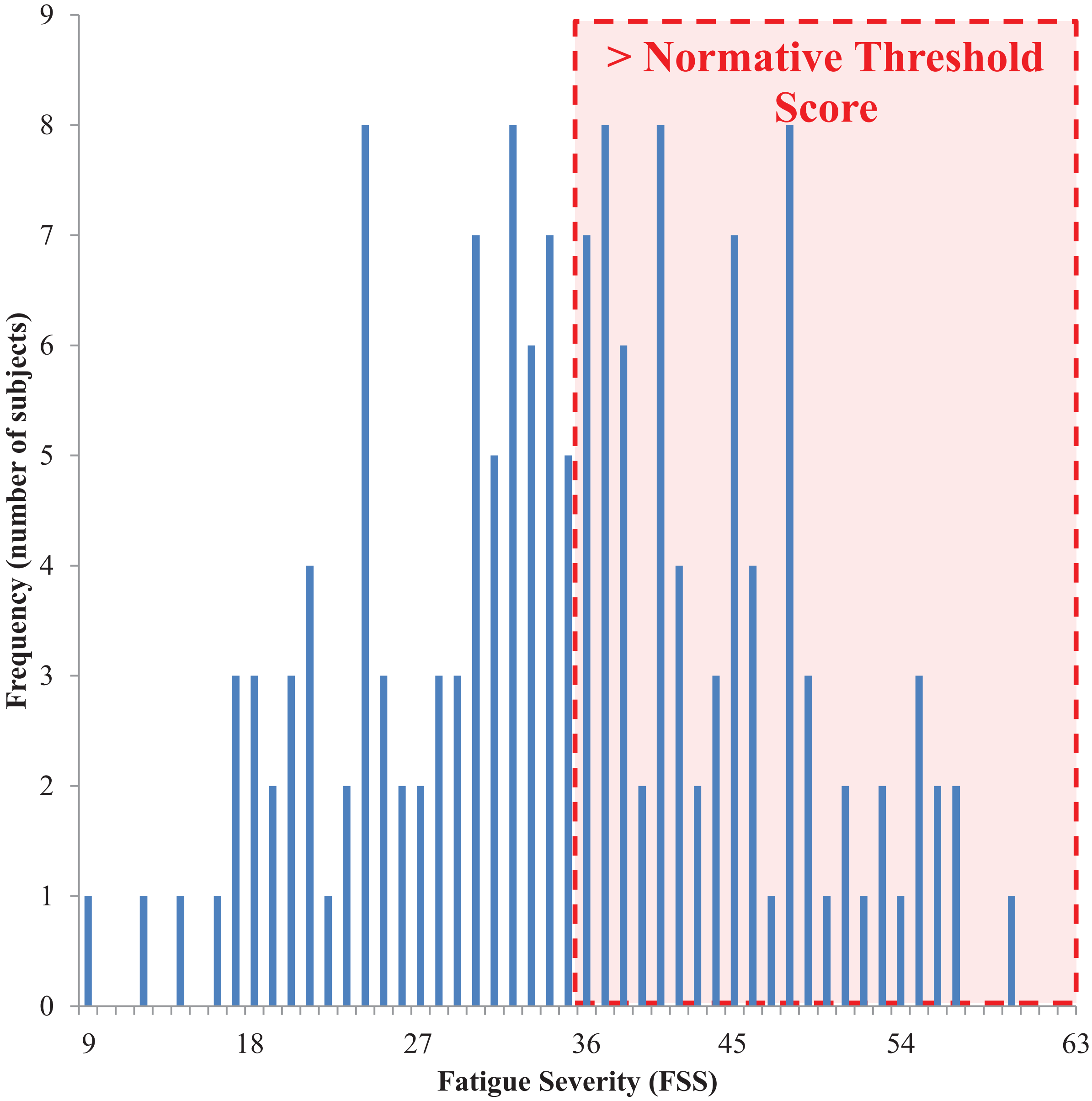

Figure 6.3 depicts the fatigue severity (FSS) scores for the total sample of general duties police officers (N=255). The histogram shows that 49% of subjects were scoring above the normative threshold score of 36, indicating a greater intensity of fatigue (Krupp et al., 1989).

Key: FSS = Fatigue Severity Scale

Figure 6.4 – Frequency distribution of subjective sleepiness for the total sample (N=255)

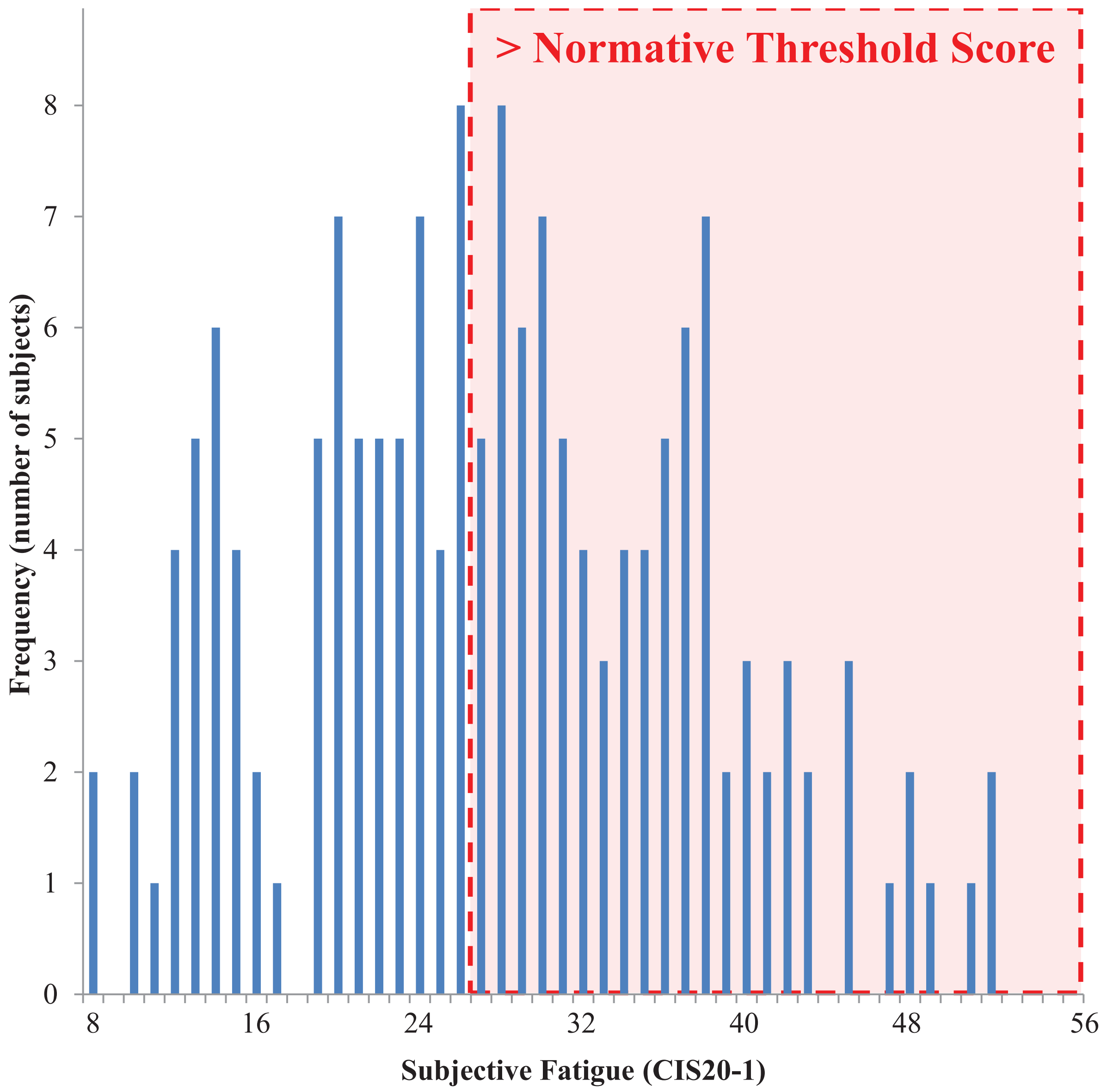

Figure 6.4 depicts the subjective fatigue (CIS20-1) scores for the total sample of general duties police officers (N=255). The histogram shows that 54% of subjects were scoring above the normative threshold score of 27, indicating an elevated or severe perception of fatigue (Vercoulen et al., 1994).

Key: CIS20 = Checklist of Individual Strength

6.1.1.2 Sleep Associations & Regression Analyses (total sample)

Pearson's correlations were performed to identify the relationship between subjects' sleepiness and fatigue with other independent variables. Where three or more independent variables were found to be significantly correlated with the dependant variable of sleepiness or fatigue prevalence, consequent multiple regressions were performed.

Police officers' sleepiness risk (ESS), fatigue severity (FSS) and total impact (CIS20) associations are all presented in Table 6.3. Sleepiness risk was negatively correlated with officers' waist-hip ratio (WHR) ($r=-0.14$, $p=0.022$), and positively associated with total travel work time (TTW) ($r=0.26$, $p=0.001$) and perception of stress (LAQ Part 2) ($r=0.35$, $p<0.001$). Similarly, the following components of the PSQI were all positively linked to sleepiness risk; subjective sleep quality ($r=0.29$, $p<0.001$), sleep duration ($r=0.16$, $p=0.009$), sleep efficiency ($r=0.13$, $p=0.042$), frequency of sleep disturbances ($r=0.27$, $p<0.001$) and daytime dysfunction ($r=0.47$, $p<0.001$), as well as global PSQI score ($r=0.30$, $p<0.001$). A subsequent multiple regression (Table 6.4) was performed using the significant correlations identified and was found to be overall significant for sleepiness risk ($F(9,143) = 7.50$, $p<0.001$). Together the independent variables explain 32% of the variance in sleepiness risk, with TTW ($p=0.028$), perception of stress ($p=0.018$), sleep duration ($p=0.042$), daytime dysfunction ($p<0.001$) and global PSQI score ($p=0.012$) being the significant predictors.

Subjects' fatigue severity was also found to be positively correlated with perception of stress ($r=0.47$, $p<0.001$) and a number of the PSQI's component scores; subjective sleep quality ($r=0.42$, $p<0.001$), sleep duration ($r=0.22$, $p=0.005$), sleep efficiency ($r=0.18$, $p=0.026$), frequency of sleep disturbances ($r=0.45$, $p<0.001$), sleep medication usage ($r=0.17$, $p=0.032$) and daytime dysfunction ($r=0.54$, $p<0.001$), as well as global PSQI score ($r=0.50$, $p<0.001$). A subsequent multiple regression (Table 6.5) was performed using the significant correlations identified and was found to be overall significant for fatigue severity ($F(8,149) = 13.00$, $p<0.001$). Together the independent variables explain 41% of the variance in fatigue severity, with perception of stress ($p=0.004$), frequency of sleep disturbances ($p=0.042$) and daytime dysfunction ($p=0.004$) being the significant predictors.

Finally, police officers' total fatigue impact was positively associated with lifestyle risk factors (LAQ Part 1) ($r=0.43$, $p<0.001$) and perception of stress ($r=0.69$, $p<0.001$), as well as the following components of the PSQI; subjective sleep quality ($r=0.54$, $p<0.001$), sleep duration ($r=0.05$, $p<0.001$), sleep efficiency ($r=0.24$, $p=0.002$), frequency of sleep disturbances ($r=0.41$, $p<0.001$), sleep medication usage ($r=0.27$, $p=0.001$) and daytime dysfunction ($r=0.54$, $p<0.001$), as well as global PSQI score ($r=0.63$, $p<0.001$). A subsequent multiple regression (Table 6.6) was performed using the significant correlations identified and was found to be overall significant for total fatigue impact ($F(8,148) = 28.74$, $p<0.001$). Together the independent variables explain 64% of the variance in total fatigue impact, with lifestyle risk factors ($p=0.024$), perception of stress ($p<0.001$), and global PSQI score ($p=0.030$) being the significant predictors.

Table 6.3 – Significant correlations between independent variables and sleep factors for the total sample (N=255)

Total sample (N=255)	Independent Variables	Sleepiness Risk (ESS)		Fatigue Severity (FSS)		Total Fatigue Impact (CIS20)	
		r	*p*	*r*	*p*	*r*	*p*
	WHR	-0.14	**0.022**	-	-	-	-
	TTW	0.26	**0.001**	-	-	-	-
	Lifestyle Risk Factors (LAQ Part 1)	-	-	-	-	0.43	**<0.001**
	Perception of Stress (LAQ Part 2)	0.35	**<0.001**	0.47	**<0.001**	0.69	**<0.001**
	Subjective Sleep Quality (PSQIC1)	0.29	**<0.001**	0.42	**<0.001**	0.54	**<0.001**
	Sleep Duration (PSQIC3)	0.16	**0.009**	0.22	**0.005**	0.33	**<0.001**
	Sleep Efficiency (PSQIC4)	0.13	**0.042**	0.18	**0.026**	0.24	**0.002**
	Sleep Disturbances (PSQIC5)	0.27	**<0.001**	0.45	**<0.001**	0.41	**<0.001**
	Sleep Medication Usage (PSQIC6)	-	-	0.17	**0.032**	0.27	**0.001**
	Daytime Dysfunction (PSQIC7)	0.47	**<0.001**	0.54	**<0.001**	0.54	**<0.001**
	PSQI Global	0.30	**<0.001**	0.50	**<0.001**	0.63	**<0.001**

Table 6.3 shows significant results from Pearson's correlations between sleepiness risk (ESS), fatigue severity (FSS) and total CIS20 score with other independent variables for the total sample (N=255).

Key: CIS20 = Checklist of Individual Strength, ESS = Epworth Sleepiness Scale, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQI = Pittsburgh Sleep Quality Index, TTW = Total Travel Work Time, WHR = Waist-Hip Ratio; p = Level of statistical significance (p=<0.05 (in bold))

Table 6.4 – Multiple regression between sleepiness risk and significantly correlated variables in the total sample (N=255)

Total Sample (N=255)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Sleepiness Risk (ESS)	0.57	0.32	0.28	3.47	**<0.001**
	B	Std. Error	Beta	T	p
(Constant)	7.36	3.45		2.13	**0.035**
WHR	-5.02	3.96	-0.09	-1.27	0.21
TTW	0.00	0.00	0.16	2.22	**0.028**
Perception of Stress (LAQ Part 2)	0.09	0.04	0.19	2.39	**0.018**
Subjective Sleep Quality (PSQIC1)	0.91	0.64	0.18	1.42	0.16
Sleep Duration (PSQIC3)	0.94	0.46	0.21	2.05	**0.042**
Sleep Efficiency (PSQIC4)	0.75	0.45	0.18	1.69	0.09
Sleep Disturbances (PSQIC5)	0.81	0.66	0.11	1.22	0.22
Daytime Dysfunction (PSQIC7)	2.42	0.50	0.49	4.88	**<0.001**
PSQI Global	-0.66	0.26	-0.58	-2.55	**0.012**

Table 6.4 shows multiple regression analysis between sleepiness risk (ESS) and significant variables as determined by Pearson's correlations; WHR, TTW, perception of stress (LAQ Part 2), subjective sleep quality, sleep duration, sleep efficiency, frequency of sleep disturbances and daytime dysfunction (PSQI Components 1, 3, 4, 5 and 7 respectively), as well as global PSQI score for the total sample (N=255).

Key: ESS = Epworth Sleepiness Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQI = Pittsburgh Sleep Quality Index, TTW = Total Travel Work Time, WHR = Waist-Hip Ratio; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Table 6.5 – Multiple regression between fatigue severity and significantly correlated variables in the total sample (N=255)

Total Sample (N=255)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Fatigue Severity (FSS)	0.64	0.41	0.38	8.19	**<0.001**
	B	**Std. Error**	**Beta**	**T**	**p**
(Constant)	20.70	1.82		11.39	**<0.001**
Perception of Stress (LAQ Part 2)	0.24	0.08	0.22	2.91	**0.004**
Subjective Sleep Quality (PSQIC1)	0.24	1.54	0.02	0.16	0.88
Sleep Duration (PSQIC3)	0.34	1.17	0.03	0.29	0.77
Sleep Efficiency (PSQIC4)	-0.70	1.19	-0.07	-0.59	0.56
Sleep Disturbances (PSQIC5)	3.25	1.58	0.17	2.05	**0.042**
Sleep Medication Usage (PSQIC6)	0.33	1.35	0.02	0.24	0.81
Daytime Dysfunction (PSQIC7)	3.73	1.28	0.30	2.91	**0.004**
PSQI Global	0.38	0.78	0.13	0.48	0.63

Table 6.5 shows multiple regression analysis between fatigue severity (FSS) and significant variables as determined by Pearson's correlations; perception of stress (LAQ Part 2), subjective sleep quality, sleep duration, sleep efficiency, frequency of sleep disturbances, sleep medication usage and daytime dysfunction (PSQI Components 1, 3, 4, 5, 6 and 7 respectively), as well as global PSQI score for the total sample (N=255).

Key: FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQI = Pittsburgh Sleep Quality Index, TTW = Total Travel Work Time, WHR = Waist-Hip Ratio; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Table 6.6 – Multiple regression between total fatigue impact and significantly correlated variables in the total sample (N=255)

Total Sample (N=255)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Total Fatigue Impact (CIS20)	0.80	0.64	0.61	12.16	**<0.001**
	B	Std. Error	Beta	T	p
(Constant)	28.17	3.02		9.33	**<0.001**
Lifestyle Risk Factors (LAQ Part 1)	0.42	0.18	0.13	2.28	**0.024**
Perception of Stress (LAQ Part 2)	0.95	0.13	0.45	7.60	**<0.001**
Subjective Sleep Quality (PSQIC1)	0.13	2.30	0.01	0.06	0.96
Sleep Duration (PSQIC3)	0.00	1.74	0.00	0.00	1.00
Sleep Efficiency (PSQIC4)	-3.23	1.77	-0.16	-1.82	0.07
Sleep Disturbances (PSQIC5)	-1.14	2.36	-0.03	-0.48	0.63
Sleep Medication Usage (PSQIC6)	-0.47	2.01	-0.02	-0.23	0.82
Daytime Dysfunction (PSQIC7)	1.49	1.91	0.06	0.78	0.44
PSQI Global	2.54	1.16	0.47	2.19	**0.030**

Table 6.6 shows multiple regression analysis between total fatigue impact (CIS20) and significant variables as determined by Pearson's correlations; lifestyle risk factors (LAQ Part 1), perception of stress (LAQ Part 2), subjective sleep quality, sleep duration, sleep efficiency, frequency of sleep disturbances, sleep medication usage and daytime dysfunction (PSQI Components 1, 3, 4, 5, 6 and 7 respectively), as well as global PSQI score for the total sample (N=255).

Key: CIS20 = Checklist of Individual Strength, LAQ = Lifestyle Appraisal Questionnaire, PSQI = Pittsburgh Sleep Quality Index, TTW = Total Travel Work Time, WHR = Waist-Hip Ratio; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

6.1.2 Results: Sleep and Shift Work (sex comparison)

This section presents the results in the context of comparing the sexes; 179 male and 76 female general duties police officers made up the total sample (N=255). Their sleep quality, fatigue and sleepiness prevalence, with associated correlations and regression analyses, follow.

6.1.2.1 Sleep Questionnaire Data (sex comparison)

Mean (± SD) quality of sleep, fatigue and sleepiness prevalence is provided for male (n=179) and female (n=76) police officers. Overall sleep quality (PSQI), and its subcomponent scores, are presented in Table 6.7, with both male and female officers' average score falling above the normative threshold provided by Buysse and colleagues (1989). Independent sample t-tests performed found no significant differences in overall sleep quality, or any of the subcomponent scores, between police officers based on their sex.

Table 6.7 – Mean overall sleep quality for male (n=179) and female (n=76) police officers

Global PSQI Score	Male (n=179)	Female (n=76)
Overall Sleep Quality	6.55 ± 3.47	7.24 ± 3.84
Sleep Component	Mean ± SD	Mean ± SD
Subjective Sleep Quality (PSQIC1)	1.21 ± 0.76	1.26 ± 0.87
Sleep Onset Latency (PSQIC2)	1.34 ± 0.98	1.37 ± 0.99
Sleep Duration (PSQIC3)	0.95 ± 0.93	0.84 ± 0.94
Sleep Efficiency (PSQIC4)	0.66 ± 0.93	0.88 ± 1.06
Sleep Disturbances (PSQIC5)	1.21 ± 0.57	1.33 ± 0.47
Sleep Medication Usage (PSQIC6)	0.20 ± 0.58	0.37 ± 0.81
Daytime Dysfunction (PSQIC7)	0.98 ± 0.85	1.18 ± 0.76

Table 6.7 shows mean overall sleep quality for the male and female general duties police officers (n=179 and n=76 respectively). Independent sample t-tests were performed and found no significant differences based on sex. The maximum score for the PSQI (overall sleep quality) is 21, with greater scores indicating a worse quality of sleep (Buysse et al., 1989). The global score is determined by summing the seven component values, which assess different facets of sleep, including subjective sleep quality, sleep onset latency, sleep duration, sleep efficiency, sleep disturbances, sleep medication usage and daytime dysfunction.

Key: PSQIC = Pittsburgh Sleep Quality Index Component; SD =Standard Deviation, ± = Plus and minus

Sleepiness and fatigue prevalence were also assessed for the male and female general duties police officers (Table 6.8). The mean sleepiness risk score (ESS) for both males and females was below the normative threshold value as provided by Johns (1991). Similarly, the police officers' average total fatigue impact (CIS20) scores were also below the normative threshold value (Vercoulen et al., 1994). By comparison, the male police officers' mean fatigue severity (FSS) score was below the normative threshold value, while female officers' fell slightly above it (Krupp et al., 1989). Despite this, independent sample t-tests performed found no significant differences in sleepiness risk (ESS), fatigue severity (FSS) or total fatigue impact (CIS20) between police officers based on their sex.

Table 6.8 – Mean sleepiness and fatigue scores for male (n=179) and female (n=76) police officers

Variable	Male (n=179)	Female (n=76)
Sleepiness Risk (ESS)	6.94 ± 4.29	6.92 ± 3.58
Fatigue Severity (FSS)	34.24 ± 10.30	37.04 ± 10.45
Total Fatigue Impact (CIS20)	62.31 ± 19.64	65.53 ± 19.42
CIS20 Component	Mean ± SD	Mean ± SD
Subjective Fatigue (CIS20-1)	27.05 ± 9.96	29.73 ± 10.13
Reduced Concentration (CIS20-2)	15.54 ± 5.96	15.94 ± 5.24
Reduced Motivation (CIS20-3)	11.62 ± 4.10	12.41 ± 4.27
Reduced Activity (CIS20-4)	8.11 ± 3.71	7.45 ± 3.47

Table 6.2 shows mean sleepiness risk, fatigue severity and total fatigue for the total sample of general duties police officers (N=255). The maximum score for the ESS (sleepiness risk) is 24, with greater scores indicating a greater likelihood of dozing (Johns, 1991). The maximum score for the FSS (fatigue severity) is 63, with greater scores indicating a stronger severity of fatigue impact (Krupp et al., 1989). The maximum score for the CIS20 is determined by summing the four component values, which assess different aspects of fatigue, including subjective fatigue and reduced concentration, motivation and activity (Vercoulen et al., 1994).

Key: CIS20 = Checklist of Individual Strength, ESS = Epworth Sleepiness Scale, FSS = Fatigue Severity Scale; SD = Standard Deviation, ± = Plus and minus

6.1.2.2 Sleep Associations & Regression Analyses (sex comparison)

Pearson's correlations were performed to identify the relationship between male and females' sleepiness and fatigue with other independent variables. Where three or more independent variables were found to be significantly correlated with the dependant variable of sleepiness or fatigue prevalence, consequent multiple regressions were performed

Sleepiness risk was found to have a number of significant relationships with other independent variables when comparing between the sexes (Table 6.9). Male police officers' sleepiness risk (ESS) was positively associated with perception of stress (LAQ Part 2) ($r=0.36$, $p<0.001$) and the following components of the PSQI; subjective sleep quality ($r=0.25$, $p=0.001$), frequency of sleep disturbances ($r=0.32$, $p<0.001$) and daytime dysfunction ($r=0.48$, $p<0.001$), as well as global PSQI score ($r=0.30$, $p<0.001$). A subsequent multiple regression (Table 6.10) was performed using the significant correlations identified and was found to be overall significant for sleepiness risk ($F(5,173) = 12.95$, $p<0.001$). Together the independent variables explain 27% of the variance in male officers' sleepiness risk, with perception of stress ($p=0.031$) and daytime dysfunction ($p<0.001$) being the significant predictors.

By comparison, female police officers' sleepiness risk was negatively correlated with their age ($r=-0.27$, $p=0.018$) and WHR ($r=-0.32$, $p=0.005$). Similarly though, it was also positively associated with females' TTW ($r=0.43$, $p=0.001$), perception of stress ($r=0.33$, $p=0.004$) and a number of the PSQI's component scores; subjective sleep quality ($r=0.40$, $p<0.001$), sleep duration ($r=0.25$, $p=0.027$) and daytime dysfunction ($r=0.47$, $p<0.001$), as well as global PSQI score ($r=0.32$, $p=0.004$). A subsequent multiple regression (Table 6.11) was performed using the significant correlations identified and was found to be overall significant for sleepiness risk ($F(8,42) = 4.30$, $p=0.001$). Together the independent variables explain 45% of the variance in female officers' sleepiness risk, with WHR ($p=0.036$) and TTW ($p=0.032$) being the significant predictors.

Table 6.9 – Significant correlations between independent variables and sleepiness risk for male (n=179) and female (n=76) police officers

Independent Variables	Sleepiness Risk (ESS)			
	Male (n=179)		Female (n=76)	
	r	*p*	*r*	*p*
Years of Age	-	**-**	-0.27	**0.018**
WHR	-	**-**	-0.32	**0.005**
TTW	-	**-**	0.43	**0.001**
Perception of Stress (LAQ Part 2)	0.36	**<0.001**	0.33	**0.004**
Subjective Sleep Quality (PSQIC1)	0.25	**0.001**	0.40	**<0.001**
Sleep Duration (PSQIC3)	-	**-**	0.25	**0.027**
Sleep Disturbances (PSQIC5)	0.32	**<0.001**	-	-
Daytime Dysfunction (PSQIC7)	0.48	**<0.001**	0.47	**<0.001**
PSQI Global	0.30	**<0.001**	0.32	**0.004**

Table 6.9 shows significant results from Pearson's correlations between sleepiness risk (ESS) and other independent variables for the male and female general duties police officers (n=179 and n=76 respectively).

Key: ESS = Epworth Sleepiness Risk, LAQ = Lifestyle Appraisal Questionnaire, PSQI = Pittsburgh Sleep Quality Index, TTW = Total Travel Work Time, WHR = Waist-Hip Ratio; n=Sample size, p = Level of statistical significance (p=<0.05 (in bold))

Table 6.10 – Multiple regression between sleepiness risk and significantly correlated variables in male police officers (n=179)

Male (n=179)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Sleepiness Risk (ESS)	0.52	0.27	0.25	3.71	**<0.001**
	B	Std. Error	Beta	T	p
(Constant)	3.37	0.72		4.70	**<0.001**
Perception of Stress (LAQ Part 2)	0.08	0.04	0.17	2.18	**0.031**
Subjective Sleep Quality (PSQIC1)	0.24	0.57	0.04	0.42	0.67
Sleep Disturbances (PSQIC5)	1.15	0.61	0.15	1.89	0.06
Daytime Dysfunction (PSQIC7)	2.14	0.43	0.42	4.95	**<0.001**
PSQI Global	-0.21	0.15	-0.17	-1.43	0.15

Table 6.10 shows multiple regression analysis between sleepiness risk (ESS) and significant variables as determined by Pearson's correlations; perception of stress (LAQ Part 2), subjective sleep quality, frequency of sleep disturbances and daytime dysfunction (PSQI Components 1, 5 and 7 respectively), as well as global PSQI score for the male general duties police officers (n=179).

Key: ESS = Epworth Sleepiness Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQI = Pittsburgh Sleep Quality Index; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Table 6.11 – Multiple regression between sleepiness risk and significantly correlated variables in female police officers (n=76)

Female (n=76)	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**p**
Sleepiness Risk (ESS)	0.67	0.45	0.35	2.90	**0.001**
	B	**Std. Error**	**Beta**	**T**	**P**
(Constant)	17.35	5.64		3.07	**0.004**
Age	-0.04	0.06	-0.09	-0.72	0.48
WHR	-15.79	7.31	-0.27	-2.16	**0.036**
TTW	0.00	0.00	0.30	2.21	**0.032**
Perception of Stress (LAQ Part 2)	0.05	0.05	0.12	0.86	0.39
Subjective Sleep Quality (PSQIC1)	1.28	0.89	0.31	1.44	0.16
Sleep Duration (PSQIC3)	0.31	0.70	0.08	0.44	0.66
Daytime Dysfunction (PSQIC7)	1.22	0.72	0.26	1.69	0.10
PSQI Global	-0.28	0.26	-0.30	-1.09	0.28

Table 6.11 shows multiple regression analysis between sleepiness risk (ESS) and significant variables as determined by Pearson's correlations; years of age, WHR, TTW, perception of stress (LAQ Part 2), subjective sleep quality, sleep duration and daytime dysfunction (PSQI Components 1, 3 and 7 respectively), as well as global PSQI score for the female general duties police officers (n=76).

Key: ESS = Epworth Sleepiness Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQI = Pittsburgh Sleep Quality Index, TTW = Total Travel Work Time, WHR = Waist-Hip Ratio; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Fatigue severity (FSS) was found to share a number of similar positive relationships with sleepiness risk when comparing between the sexes (Table 6.12). Male police officers' fatigue severity was positively associated with perception of stress ($r=0.47$, $p<0.001$) and the following components of the PSQI; subjective sleep quality ($r=0.39$, $p<0.001$), sleep onset latency ($r=0.40$, $p<0.001$), frequency of sleep disturbances ($r=0.48$, $p<0.001$), sleep medication usage ($r=0.21$, $p=0.028$) and daytime dysfunction ($r=0.59$, $p<0.001$), as well as global PSQI score ($r=0.53$, $p<0.001$). A subsequent multiple regression (Table 6.13) was performed using the significant correlations identified and was found to be overall significant for fatigue severity ($F(7,100) = 13.00$, $p<0.001$). Together the independent variables explain 48% of the variance in male officers' fatigue severity, with frequency of sleep disturbances ($p=0.007$), sleep medication usage ($p=0.048$) and daytime dysfunction ($p<0.001$) being the significant predictors.

By comparison, female police officers' fatigue severity was also positively correlated with their TTW ($r=0.40$, $p=0.004$) and perception of stress ($r=0.45$, $p=0.001$), as well as the following components of the PSQI; subjective sleep quality ($r=0.47$, $p=0.001$), sleep duration ($r=0.30$, $p=0.030$), frequency of sleep disturbances ($r=0.33$, $p=0.019$) and daytime dysfunction ($r=0.43$, $p=0.002$), as well as global PSQI score ($r=0.42$, $p=0.002$). A subsequent multiple regression (Table 6.14) was performed using the significant correlations identified and was found to be overall significant for fatigue severity ($F(7,43) = 3.87$, $p=0.002$). Together the independent variables explain 39% of the variance in female officers' fatigue severity, with the only significant predictor being perception of stress ($p=0.034$).

Table 6.12 – Significant correlations between independent variables and fatigue severity for male (n=179) and female (n=76) police officers

Independent Variables	Fatigue Severity (FSS)			
	Male (n=179)		Female (n=76)	
	r	*p*	*r*	*p*
TTW	-	**-**	0.40	**0.004**
Perception of Stress (LAQ Part 2)	0.47	**<0.001**	0.45	**0.001**
Subjective Sleep Quality (PSQIC1)	0.39	**<0.001**	0.47	**0.001**
Sleep Onset Latency (PSQIC2)	0.40	**<0.001**	-	-
Sleep Duration (PSQIC3)	-	**-**	0.30	**0.030**
Sleep Disturbances (PSQIC5)	0.48	**<0.001**	0.33	**0.019**
Sleep Medication Usage (PSQIC6)	0.21	**0.028**	-	**-**
Daytime Dysfunction (PSQIC7)	0.59	**<0.001**	0.43	**0.002**
PSQI Global	0.53	**<0.001**	0.42	**0.002**

Table 6.12 shows significant results from Pearson's correlations between fatigue severity (FSS) and other independent variables for the male and female general duties police officers (n=179 and n=76 respectively).

Key: FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQI = Pittsburgh Sleep Quality Index, TTW = Total Travel Work Time, WHR = Waist-Hip Ratio; n=Sample size, p = Level of statistical significance (p=<0.05 (in bold))

Table 6.13 – Multiple regression between fatigue severity and significantly correlated variables in male police officers (n=179)

Male (n=179)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Fatigue Severity (FSS)	0.69	0.48	0.44	7.71	**<0.001**
	B	Std. Error	Beta	T	p
(Constant)	20.49	1.94		10.58	**<0.001**
Perception of Stress (LAQ Part 2)	0.17	0.10	0.15	1.72	0.09
Subjective Sleep Quality (PSQIC1)	-0.22	1.55	-0.02	-0.14	0.89
Sleep Onset Latency (PSQIC2)	2.07	1.19	0.20	1.73	0.09
Sleep Disturbances (PSQIC5)	4.63	1.69	0.26	2.75	**0.007**
Sleep Medication Usage (PSQIC6)	2.81	1.40	0.16	2.01	**0.048**
Daytime Dysfunction (PSQIC7)	4.95	1.20	0.41	4.11	**<0.001**
PSQI Global	-0.35	0.56	-0.12	-0.63	0.53

Table 6.13 shows multiple regression analysis between fatigue severity (FSS) and significant variables as determined by Pearson's correlations; perception of stress (LAQ Part 2), subjective sleep quality, sleep onset latency, frequency of sleep disturbances, sleep medication usage and daytime dysfunction (PSQI Components 1, 2, 5, 6 and 7 respectively), as well as global PSQI score for the male general duties police officers (n=179).

Key: FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQI = Pittsburgh Sleep Quality Index; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Table 6.14 – Multiple regression between fatigue severity and significantly correlated variables in female police officers (n=76)

Female (n=76)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Fatigue Severity (FSS)	0.62	0.39	0.29	8.83	**0.002**
	B	**Std. Error**	**Beta**	**T**	**p**
(Constant)	22.05	4.28		5.16	**<0.001**
TTW	0.01	0.01	0.23	1.66	0.11
Perception of Stress (LAQ Part 2)	0.35	0.16	0.31	2.19	**0.034**
Subjective Sleep Quality (PSQIC1)	2.16	2.72	0.18	0.80	0.43
Sleep Duration (PSQIC3)	1.44	2.11	0.13	0.68	0.50
Sleep Disturbances (PSQIC5)	2.57	3.18	0.12	0.81	0.42
Daytime Dysfunction (PSQIC7)	2.36	2.12	0.17	1.11	0.27
PSQI Global	-0.52	0.78	-0.19	-0.66	0.51

Table 6.14 shows multiple regression analysis between fatigue severity (FSS) and significant variables as determined by Pearson's correlations; TTW, perception of stress (LAQ Part 2), subjective sleep quality, sleep duration, frequency of sleep disturbances and daytime dysfunction (PSQI Components 1, 3, 5 and 7 respectively), as well as global PSQI score for the female general duties police officers (n=76).

Key: FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQI = Pittsburgh Sleep Quality Index, TTW = Total Travel Work Time; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Finally, total fatigue impact (CIS20) (Table 6.15) was found to have a number of significant associations when comparing between the sexes. Male officers' only significant correlation identified with total fatigue impact was lifestyle risk factors (LAQ Part 1) ($r=0.23$, $p=0.018$). As such, no regressions were performed for males' total fatigue impact as there were less than three significant independent variables correlated.

By comparison, females' total fatigue impact was positively associated with their perception of stress ($r=0.61$, $p =<.001$) and the following components of the PSQI; subjective sleep quality ($r=0.58$, $p<0.001$), sleep onset latency ($r=0.36$, $p=0.009$), frequency of sleep disturbances ($r=0.39$, $p=0.004$), sleep medication usage ($r=0.35$, $p=0.012$) and daytime dysfunction ($r=0.38$, $p=0.006$), as well as global PSQI score ($r=0.54$, $p<0.001$). A subsequent multiple regression (Table 6.16) was performed using the significant correlations identified and was found to be overall significant for total fatigue impact ($F(7,43) = 7.38$, $p<0.001$). Together the independent variables explain 55% of the variance in female officers' total fatigue impact, with the only significant predictor being perception of stress ($p=0.001$).

Table 6.15 – Significant correlations between independent variables and total fatigue impact for male (n=179) and female (n=76) police officers

Independent Variables	Total Fatigue Impact (CIS20)			
	Male (n=179)		Female (n=76)	
	r	*p*	*r*	*p*
Lifestyle Risk Factors (LAQ Part 1)	0.23	**0.018**	-	-
Perception of Stress (LAQ Part 2)	-	-	0.61	**<0.001**
Subjective Sleep Quality (PSQIC1)	-	-	0.58	**<0.001**
Sleep Onset Latency (PSQIC2)	-	-	0.36	**0.009**
Sleep Disturbances (PSQIC5)	-	-	0.39	**0.004**
Sleep Medication Usage (PSQIC6)	-	-	0.35	**0.012**
Daytime Dysfunction (PSQIC7)	-	-	0.38	**0.006**
PSQI Global	-	-	0.54	**<0.001**

Table 6.12 shows significant results from Pearson's correlations between total fatigue impact (CIS20) and other independent variables for the male and female general duties police officers (n=179 and n=76 respectively).

Key: CIS20 = Checklist of Individual Strength, LAQ = Lifestyle Appraisal Questionnaire, PSQI = Pittsburgh Sleep Quality Index; n=Sample size, p = Level of statistical significance (p=<0.05 (in bold))

Table 6.16 – Multiple regression between total fatigue impact and significantly correlated variables in female police officers (n=76)

Female (n=76)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Total Fatigue Impact (CIS20)	0.74	0.55	0.47	14.12	**<0.001**
	B	Std. Error	Beta	T	p
(Constant)	29.46	7.27		4.05	**<0.001**
Perception of Stress (LAQ Part 2)	0.90	0.25	0.43	3.59	**0.001**
Subjective Sleep Quality (PSQIC1)	4.78	4.33	0.21	1.10	0.28
Sleep Onset Latency (PSQIC2)	3.95	3.08	0.20	1.28	0.21
Sleep Disturbances (PSQIC5)	7.67	5.52	0.19	1.39	0.17
Sleep Medication Usage (PSQIC6)	2.85	3.19	0.12	0.89	0.38
Daytime Dysfunction (PSQIC7)	1.71	3.76	0.07	0.45	0.65
PSQI Global	-0.49	1.48	-0.10	-0.33	0.74

Table 6.16 shows multiple regression analysis between total fatigue impact (CIS20) and significant variables as determined by Pearson's correlations; perception of stress (LAQ Part 2), subjective sleep quality, sleep onset latency, frequency of sleep disturbances, sleep medication usage and daytime dysfunction (PSQI Components 1, 2, 5, 6 and 7 respectively), as well as global PSQI score for the female general duties police officers (n=76).

Key: FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQI = Pittsburgh Sleep Quality Index; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

6.1.3 Results: Sleep and Shift Work (shift comparison)

This section presents the results in the context of comparing the general duties police officers based on the shift they were working at time of assessment; 148 were working a day shift (0600 – 1800) and 107 were working a night shift (1800 – 0600) that comprise the total sample (N=255). Their sleep quality, fatigue and sleepiness prevalence, with associated correlations and regression analyses, follow.

6.1.3.1 Sleep Questionnaire Data (shift comparison)

Mean (± SD) quality of sleep, fatigue and sleepiness prevalence is provided for police officers working a day shift (n=148) or night shift (n=107). Overall sleep quality (PSQI), and its subcomponent scores, are presented in Table 6.17, with both day and night-shift working officers' average score falling above the normative threshold provided by Buysse and colleagues (1989). Independent sample t-tests performed found no significant differences in overall sleep quality, or any of the subcomponent scores, between police officers based on their shift.

Table 6.17 – Mean overall sleep quality for police officers working a day (n=148) or night shift (n=107)

Global PSQI Score	Day (n=148)	Night (n=107)
Overall Sleep Quality	6.80 ± 3.25	6.69 ± 4.02
Sleep Component	Mean ± SD	Mean ± SD
Subjective Sleep Quality (PSQIC1)	1.24 ± 0.72	1.22 ± 0.88
Sleep Onset Latency (PSQIC2)	1.33 ± 0.94	1.37 ± 1.04
Sleep Duration (PSQIC3)	0.95 ± 0.92	0.88 ± 0.96
Sleep Efficiency (PSQIC4)	0.73 ± 0.98	0.71 ± 0.97
Sleep Disturbances (PSQIC5)	1.25 ± 0.51	1.24 ± 0.60
Sleep Medication Usage (PSQIC6)	0.24 ± 0.64	0.27 ± 0.69
Daytime Dysfunction (PSQIC7)	1.07 ± 0.78	1.00 ± 0.89

Table 6.17 shows mean overall sleep quality for the general duties police officers working a day or night shift (n=148 and n=107 respectively). Independent sample t-tests were performed and found no significant differences based on shift. The maximum score for the PSQI (overall sleep quality) is 21, with greater scores indicating a worse quality of sleep (Buysse et al., 1989). The global score is determined by summing the seven component values, which assess different facets of sleep, including subjective sleep quality, sleep onset latency, sleep duration, sleep efficiency, sleep disturbances, sleep medication usage and daytime dysfunction.

Key: PSQIC = Pittsburgh Sleep Quality Index Component; SD =Standard Deviation, ± = Plus and minus

Sleepiness and fatigue prevalence were also assessed for the male and female general duties police officers (Table 6.18). The mean sleepiness risk score (ESS) for both day and night shift were below the normative threshold value as provided by Johns (1991). Similarly, the police officers' average fatigue severity (FSS) and total fatigue impact (CIS20) scores were also below the normative threshold value when working a day or night shift (Krupp et al., 1989; Vercoulen et al., 1994). Independent sample t-tests were performed, and only day-shift working officers mean Reduced Concentration (CIS20-2) score (16.84 ± 5.79) was found to be significantly higher than their night-working peers (13.73 ± 5.09), when comparing police officers based on their shift.

Table 6.18 – Mean sleepiness and fatigue scores for police officers working a day (n=148) or night shift (n=107)

Variable	Day (n=148)	Night (n=107)
Sleepiness Risk (ESS)	7.25 ± 4.30	6.50 ± 3.75
Fatigue Severity (FSS)	35.94 ± 9.62	33.82 ± 11.54
Total Fatigue Impact (CIS20)	65.55 ± 18.86	59.72 ± 20.32
CIS20 Component	Mean ± SD	Mean ± SD
Subjective Fatigue (CIS20-1)	28.92 ± 9.60	26.23 ± 10.66
Reduced Concentration (CIS20-2)*	16.84 ± 5.79	13.73 ± 5.09
Reduced Motivation (CIS20-3)	11.98 ± 3.86	11.70 ± 4.64
Reduced Activity (CIS20-4)	7.81 ± 3.42	8.05 ± 4.00

Table 6.18 shows mean sleepiness risk, fatigue severity and total fatigue for the general duties police officers working a day or night shift (n=148 and n=107 respectively). Independent sample t-tests were performed and only the level of concentration reduction was found to be significantly different based on shift (p=0.010). The maximum score for the ESS (sleepiness risk) is 24, with greater scores indicating a greater likelihood of dozing(Johns, 1991). The maximum score for the FSS (fatigue severity) is 63, with greater scores indicating a stronger severity of fatigue impact (Krupp et al., 1989). The maximum score for the CIS20 is determined by summing the four component values, which assess different aspects of fatigue, including subjective fatigue and reduced concentration, motivation and activity (Vercoulen et al., 1994).

Key: CIS20 = Checklist of Individual Strength, ESS = Epworth Sleepiness Scale, FSS = Fatigue Severity Scale; SD = Standard Deviation, ± = Plus and minus, * = Level of statistical significance (p<0.01)

6.1.3.2 Sleep Associations & Regression Analyses (shift comparison)

Pearson's correlations were performed to identify the relationship between police officers' sleepiness and fatigue with other independent variables depending on working a day or night shift. Where three or more independent variables were found to be significantly correlated with the dependant variable of stress perception, consequent multiple regressions were performed.

Sleepiness risk was found to have a number of significant relationships with other independent variables when comparing between shifts (Table 6.19). Officers working the day shift's sleepiness risk was positively associated with TTW ($r=0.26$, $p=0.010$) and perception of stress (LAQ Part 2) ($r=0.29$, $p<0.001$), as well as the following components of the PSQI; subjective sleep quality ($r=0.35$, $p<0.001$), frequency of sleep disturbances ($r=0.20$, $p=0.017$) and daytime dysfunction ($r=0.54$, $p<0.001$), as well as global PSQI score ($r=0.32$, $p<0.001$). A subsequent multiple regression (Table 6.20) was performed using the significant correlations identified and was found to be overall significant for sleepiness risk ($F(6,89) = 7.37$, $p<0.001$). Together the independent variables explain 33% of the variance in day-shift working officers' sleepiness risk, with the only covariate of daytime dysfunction ($p<0.001$) being a significant predictor.

By comparison, officers' sleepiness risk that were working at night was also positively correlated to their perception of stress ($r=0.43$, $p<0.001$) and the same PSQI components; subjective sleep quality ($r=0.22$, $p=0.024$), frequency of sleep disturbances ($r=0.38$, $p<0.001$) and daytime dysfunction ($r=0.39$, $p<0.001$), as well as global PSQI score ($r=0.28$, $p=0.004$). A subsequent multiple regression (Table 6.21) was performed using the significant correlations identified and was found to be overall significant for sleepiness risk ($F(5,101) = 6.70$, $p<0.001$). Together the independent variables explain 25% of the variance in night-shift working officers' sleepiness risk, with perception of stress ($p=0.022$) and daytime dysfunction ($p=0.025$) being the significant predictors.

Table 6.19 – Significant correlations between independent variables and sleepiness risk for police officers working a day (n=148) or night shift (n=107)

Independent Variables	**Sleepiness Risk (ESS)**			
	Day (n=148)		**Night (n=107)**	
	r	***p***	***r***	***p***
TTW	0.26	**0.010**	-	**-**
Perception of Stress (LAQ Part 2)	0.29	**<0.001**	0.43	**<0.001**
Subjective Sleep Quality (PSQIC1)	0.35	**<0.001**	0.22	**0.024**
Sleep Disturbances (PSQIC5)	0.20	**0.017**	0.38	**<0.001**
Daytime Dysfunction (PSQIC7)	0.54	**<0.001**	0.39	**<0.001**
PSQI Global	0.32	**<0.001**	0.28	**0.004**

Table 6.19 shows significant results from Pearson's correlations between sleepiness risk (ESS) and other independent variables for the general duties police officers working a day or night shift (n=148 and n=107 respectively).

Key: ESS = Epworth Sleepiness Risk, LAQ = Lifestyle Appraisal Questionnaire, PSQI = Pittsburgh Sleep Quality Index, TTW = Total Travel Work Time; n=Sample size, p = Level of statistical significance (p=<0.05 (in bold))

Table 6.20 – Multiple regression between sleepiness risk and significantly correlated variables in police officers working a day shift (n=148)

Day Shift (n=148)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Sleepiness Risk (ESS)	0.58	0.33	0.29	3.63	**<0.001**
	B	**Std. Error**	**Beta**	**T**	**p**
(Constant)	3.02	1.22		2.48	**0.015**
TTW	0.00	0.00	0.17	1.80	0.08
Perception of Stress (LAQ Part 2)	0.04	0.04	0.08	0.82	0.41
Subjective Sleep Quality (PSQIC1)	0.50	0.89	0.08	0.56	0.58
Sleep Disturbances (PSQIC5)	-0.32	0.87	-0.04	-0.37	0.71
Daytime Dysfunction (PSQIC7)	2.71	0.61	0.49	4.46	**<0.001**
PSQI Global	-0.09	0.20	-0.07	-0.44	0.66

Table 6.20 shows multiple regression analysis between sleepiness risk (ESS) and significant variables as determined by Pearson’s correlations; TTW, perception of stress (LAQ Part 2), subjective sleep quality, frequency of sleep disturbances and daytime dysfunction (PSQI Components 1, 5 and 7 respectively), as well as global PSQI score for the general duties police officers working a day shift (n=148).

Key: ESS = Epworth Sleepiness Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQI = Pittsburgh Sleep Quality Index, TTW = Total Travel Work Time; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Table 6.21 – Multiple regression between sleepiness risk and significantly correlated variables in police officers working a night shift (n=107)

Night Shift (n=107)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Sleepiness Risk (ESS)	0.50	0.25	0.21	3.33	**<0.001**
	B	**Std. Error**	**Beta**	**T**	**p**
(Constant)	3.30	0.77		4.27	**<0.001**
Perception of Stress (LAQ Part 2)	0.12	0.05	0.27	2.32	**0.022**
Subjective Sleep Quality (PSQIC1)	-0.18	0.61	-0.04	-0.30	0.77
Sleep Disturbances (PSQIC5)	1.18	0.74	0.19	1.60	0.11
Daytime Dysfunction (PSQIC7)	1.15	0.50	0.27	2.27	**0.025**
PSQI Global	-0.12	0.16	-0.13	-0.74	0.46

Table 6.21 shows multiple regression analysis between sleepiness risk (ESS) and significant variables as determined by Pearson's correlations; perception of stress (LAQ Part 2), subjective sleep quality, frequency of sleep disturbances and daytime dysfunction (PSQI Components 1, 5 and 7 respectively), as well as global PSQI score for the general duties police officers working a night shift (n=107).

Key: ESS = Epworth Sleepiness Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQI = Pittsburgh Sleep Quality Index; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Fatigue severity (FSS) was found to share a number of similar positive relationships with sleepiness risk when comparing between the shifts (Table 6.22). Officers working a day shifts' fatigue severity was positively associated with perception of stress ($r=0.38$, $p<0.001$) and the following components of the PSQI; subjective sleep quality ($r=0.36$, $p<0.001$), sleep onset latency ($r=0.27$, $p=0.006$), frequency of sleep disturbances ($r=0.31$, $p=0.002$) and daytime dysfunction ($r=0.49$, $p<0.001$), as well as global PSQI score ($r=0.41$, $p<0.001$). A subsequent multiple regression (Table 6.23) was performed using the significant correlations identified and was found to be overall significant for fatigue severity ($F(6,92) = 6.82$, $p<0.001$). Together the independent variables explain 31% of the variance in day-shift working officers' fatigue severity, with the only covariate of daytime dysfunction ($p=0.005$) being a significant predictor.

By comparison, officers' fatigue severity that were working at night was also positively correlated with their perception of stress ($r=0.61$, $p<0.001$), as well as all of the PSQI's components; subjective sleep quality ($r=0.47$, $p<0.001$), sleep onset latency ($r=0.30$, $p=0.020$), sleep duration ($r=0.27$, $p=0.038$), sleep efficiency ($r=0.28$, $p=0.031$), frequency of sleep disturbances ($r=0.60$, $p<0.001$), sleep medication usage ($r=0.31$, $p=0.015$) and daytime dysfunction ($r=0.60$, $p<0.001$), as well as global PSQI score ($r=0.60$, $p<0.001$). A subsequent multiple regression (Table 6.24) was performed using the significant correlations identified and was found to be overall significant for fatigue severity ($F(9,50) = 8.05$, $p<0.001$). Together the independent variables explain 59% of the variance in night-shift working officers' fatigue severity, with the only significant predictor being perception of stress ($p=0.046$).

Table 6.22 – Significant correlations between independent variables and fatigue severity for police officers working a day (n=148) or night shift (n=107)

Independent Variables	**Fatigue Severity (FSS)**			
	Day (n=148)		**Night (n=107)**	
	r	***p***	***r***	***p***
Perception of Stress (LAQ Part 2)	0.38	**<0.001**	0.61	**<0.001**
Subjective Sleep Quality (PSQIC1)	0.36	**<0.001**	0.47	**<0.001**
Sleep Onset Latency (PSQIC2)	0.27	**0.006**	0.30	**0.020**
Sleep Duration (PSQIC3)	-	-	0.27	**0.038**
Sleep Efficiency (PSQIC4)	-	-	0.28	**0.031**
Sleep Disturbances (PSQIC5)	0.31	**0.002**	0.60	**<0.001**
Sleep Medication Usage (PSQIC6)	-	-	0.31	**0.015**
Daytime Dysfunction (PSQIC7)	0.49	**<0.001**	0.60	**<0.001**
PSQI Global	0.41	**<0.001**	0.60	**<0.001**

Table 6.22 shows significant results from Pearson's correlations between fatigue severity (FSS) and other independent variables for the general duties police officers working a day or night shift (n=148 and n=107 respectively).

Key: FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQI = Pittsburgh Sleep Quality Index; n=Sample size, p = Level of statistical significance (p=<0.05 (in bold))

Table 6.23 – Multiple regression between fatigue severity and significantly correlated variables in police officers working a day shift (n=148)

Day Shift (n=148)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Fatigue Severity (FSS)	0.56	0.31	0.26	8.26	**<0.001**
	B	**Std. Error**	**Beta**	**T**	**p**
(Constant)	23.70	2.58		9.19	**<.001**
Perception of Stress (LAQ Part 2)	0.19	0.10	0.19	1.93	0.06
Subjective Sleep Quality (PSQIC1)	0.88	1.87	0.07	0.47	0.64
Sleep Onset Latency (PSQIC2)	1.17	1.20	0.11	0.97	0.33
Sleep Disturbances (PSQIC5)	2.04	1.98	0.11	1.03	0.31
Daytime Dysfunction (PSQIC7)	3.97	1.38	0.32	2.88	**.005**
PSQI Global	-0.06	0.55	-0.02	-0.11	0.92

Table 6.23 shows multiple regression analysis between fatigue severity (FSS) and significant variables as determined by Pearson's correlations; perception of stress (LAQ Part 2), subjective sleep quality, sleep onset latency, frequency of sleep disturbances and daytime dysfunction (PSQI Components 1, 2, 5 and 7 respectively), as well as global PSQI score for the general duties police officers working a day shift (n=148).

Key: FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQI = Pittsburgh Sleep Quality Index; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Table 6.24 – Multiple regression between fatigue severity and significantly correlated variables in police officers working a night shift (n=107)

Night Shift (n=107)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Fatigue Severity (FSS)	0.77	0.59	0.52	8.01	**<0.001**
	B	**Std. Error**	**Beta**	**T**	**p**
(Constant)	18.34	2.60		7.06	**<0.001**
Perception of Stress (LAQ Part 2)	0.34	0.17	0.26	2.04	**0.046**
Subjective Sleep Quality (PSQIC1)	-10.01	6.18	-0.76	-1.62	0.11
Sleep Onset Latency (PSQIC2)	-10.31	5.75	-0.93	-1.79	0.08
Sleep Duration (PSQIC3)	-9.87	5.63	-0.82	-1.75	0.09
Sleep Efficiency (PSQIC4)	-9.07	5.80	-0.76	-1.56	0.13
Sleep Disturbances (PSQIC5)	-5.25	6.41	-0.27	-0.82	0.42
Sleep Medication Usage (PSQIC6)	-7.21	5.60	-0.43	-1.29	0.20
Daytime Dysfunction (PSQIC7)	-5.82	5.78	-0.45	-1.01	0.32
PSQI Global	9.94	5.64	3.47	1.76	0.08

Table 6.24 shows multiple regression analysis between fatigue severity (FSS) and significant variables as determined by Pearson's correlations; perception of stress (LAQ Part 2), subjective sleep quality, sleep onset latency, sleep duration, sleep efficiency, frequency of sleep disturbances, sleep medication usage and daytime dysfunction (PSQI Components 1 - 7 respectively), as well as global PSQI score for the general duties police officers working a night shift (n=107).

Key: FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQI = Pittsburgh Sleep Quality Index; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Finally, total fatigue impact (CIS20) (Table 6.25) was found to have a number of significant associations when comparing between the shifts. Officers working a day shifts' total fatigue impact was positively associated with lifestyle risk factors (LAQ Part 1) ($r=0.44$, $p<0.001$), perception of stress ($r=0.66$, $p<0.001$) and the following components of the PSQI; subjective sleep quality ($r=0.52$, $p<0.001$), sleep onset latency ($r=0.48$, $p<0.001$), sleep duration ($r=0.33$, $p=0.001$), frequency of sleep disturbances ($r=0.27$, $p=0.006$), sleep medication usage ($r=0.23$, $p=0.025$) and daytime dysfunction ($r=0.49$, $p<0.001$), as well as global PSQI score ($r=0.60$, $p<0.001$). A subsequent multiple regression (Table 6.26) was performed using the significant correlations identified and was found to be overall significant for total fatigue impact ($F(9,89) = 18.73$, $p<0.001$). Together the independent variables explain 65% of the variance in day-shift working officers' total fatigue impact, with lifestyle risk factors ($p=0.006$), perception of stress ($p<0.001$) and sleep onset latency ($p=0.007$) being the significant predictors.

By comparison, officers' total fatigue impact that were working at night was also positively correlated with their lifestyle risk factors ($r=0.46$, $p<0.001$), perception of stress ($r=0.73$, $p<0.001$), as well as all of the PSQI's components; subjective sleep quality ($r=0.55$, $p<0.001$), sleep onset latency ($r=0.46$, $p<0.001$), sleep duration ($r=0.33$, $p=0.011$), sleep efficiency ($r=0.37$, $p=0.004$), frequency of sleep disturbances ($r=0.58$, $p<0.001$), sleep medication usage ($r=0.34$, $p=0.009$) and daytime dysfunction ($r=0.59$, $p<0.001$), as well as global PSQI score ($r=0.66$, $p<0.001$). A subsequent multiple regression (Table 6.27) was performed using the significant correlations identified and was found to be overall significant for total fatigue impact ($F(10,49) = 21.04$, $p<0.001$). Together the independent variables explain 81% of the variance in night-shift working officers' total fatigue impact, with all of the covariates being identified as significant predictors ($p<0.001$), except for lifestyle risk factors.

Table 6.25 – Significant correlations between independent variables and total fatigue impact for police officers working a day (n=148) or night shift (n=107)

Independent Variables	Total Fatigue Impact (CIS20)			
	Day (n=148)		Night (n=107)	
	r	*p*	*r*	*p*
Lifestyle Risk Factors (LAQ Part 1)	0.44	**<0.001**	0.46	**<0.001**
Perception of Stress (LAQ Part 2)	0.66	**<0.001**	0.73	**<0.001**
Subjective Sleep Quality (PSQIC1)	0.52	**<0.001**	0.55	**<0.001**
Sleep Onset Latency (PSQIC2)	0.48	**<0.001**	0.46	**<0.001**
Sleep Duration (PSQIC3)	0.33	**0.001**	0.33	**0.011**
Sleep Efficiency (PSQIC4)	-	-	0.37	**0.004**
Sleep Disturbances (PSQIC5)	0.27	**0.006**	0.58	**<0.001**
Sleep Medication Usage (PSQIC6)	0.23	**0.025**	0.34	**0.009**
Daytime Dysfunction (PSQIC7)	0.49	**<0.001**	0.59	**<0.001**
PSQI Global	0.60	**<0.001**	0.66	**<0.001**

Table 6.25 shows significant results from Pearson's correlations between total fatigue impact (CIS20) and other independent variables for the general duties police officers working a day or night shift (n=148 and n=107 respectively).

Key: CIS20 = Checklist of Individual Strength, LAQ = Lifestyle Appraisal Questionnaire, PSQI = Pittsburgh Sleep Quality Index; n=Sample size, p = Level of statistical significance (p=<0.05 (in bold))

Table 6.26 – Multiple regression between total fatigue impact and significantly correlated variables in police officers working a day shift (n=148)

Day Shift (n=148)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Total Fatigue Impact (CIS20)	0.81	0.65	0.62	11.64	**<0.001**
	B	Std. Error	Beta	T	P
(Constant)	26.80	4.06		6.60	**<0.001**
Lifestyle Risk Factors (LAQ Part 1)	0.66	0.24	0.19	2.80	**0.006**
Perception of Stress (LAQ Part 2)	0.88	0.14	0.44	6.14	**<0.001**
Subjective Sleep Quality (PSQIC1)	4.42	2.72	0.17	1.62	0.11
Sleep Onset Latency (PSQIC2)	5.38	1.96	0.27	2.75	**0.007**
Sleep Duration (PSQIC3)	3.84	2.18	0.19	1.76	0.08
Sleep Disturbances (PSQIC5)	0.63	3.14	0.02	0.20	0.84
Sleep Medication Usage (PSQIC6)	0.99	2.43	0.03	0.41	0.69
Daytime Dysfunction (PSQIC7)	4.29	2.46	0.18	1.74	0.09
PSQI Global	-0.89	1.31	-0.15	-0.68	0.50

Table 6.26 shows multiple regression analysis between total fatigue impact (CIS20) and significant variables as determined by Pearson's correlations; lifestyle risk factors (LAQ Part 1), perception of stress (LAQ Part 2), subjective sleep quality, sleep onset latency, sleep duration, frequency of sleep disturbances, sleep medication usage and daytime dysfunction (PSQI Components 1, 2, 3, 5, 6 and 7 respectively), as well as global PSQI score for the general duties police officers working a day shift (n=148).

Key: FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQI = Pittsburgh Sleep Quality Index; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Table 6.27 – Multiple regression between total fatigue impact and significantly correlated variables in police officers working a night shift (n=107)

Night Shift (n=107)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Total Fatigue Impact (CIS20)	0.90	0.81	0.77	9.69	**<0.001**
	B	**Std. Error**	**Beta**	**T**	**p**
(Constant)	26.10	3.61		7.23	**<0.001**
Lifestyle Risk Factors (LAQ Part 1)	0.03	.23	0.01	0.12	0.90
Perception of Stress (LAQ Part 2)	0.96	0.21	0.42	4.68	**<0.001**
Subjective Sleep Quality (PSQIC1)	43.92	7.51	1.90	5.85	**<0.001**
Sleep Onset Latency (PSQIC2)	43.02	7.02	2.21	6.12	**<0.001**
Sleep Duration (PSQIC3)	40.52	6.88	1.91	5.89	**<0.001**
Sleep Efficiency (PSQIC4)	42.28	7.12	2.02	5.94	**<0.001**
Sleep Disturbances (PSQIC5)	48.27	7.83	1.42	6.17	**<0.001**
Sleep Medication Usage (PSQIC6)	43.32	6.85	1.48	6.33	**<0.001**
Daytime Dysfunction (PSQIC7)	45.35	7.08	1.99	6.40	**<0.001**
PSQI Global	-41.14	6.88	-8.15	-5.98	**<0.001**

Table 6.27 shows multiple regression analysis between total fatigue impact (CIS20) and significant variables as determined by Pearson's correlations; lifestyle risk factors (LAQ Part 1), perception of stress (LAQ Part 2), subjective sleep quality, sleep onset latency, sleep duration, sleep efficiency, frequency of sleep disturbances, sleep medication usage and daytime dysfunction (PSQI Components 1 - 7 respectively), as well as global PSQI score for the general duties police officers working a night shift (n=101).

Key: FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQI = Pittsburgh Sleep Quality Index; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

6.1.4 Results: Sleep and Shift Work (rank comparison)

This section presents the results in the context of comparing the general duties police officers based on their rank; 57 were probationary constables (PC) (<1 year service), 99 were constables (C), 53 were senior constables (SC) and 46 were sergeants (Sgt) comprising the total sample (N=255). Their sleep quality, fatigue and sleepiness prevalence, with associated correlations and regression analyses, follow.

6.1.4.1 Sleep Questionnaire Data (rank comparison)

Mean (± SD) quality of sleep, fatigue and sleepiness prevalence is provided for PC (n=57), C (n=99), SC (n=53) and Sgt (n=46). Overall sleep quality (PSQI), and its subcomponent scores, are presented in Table 6.28, with all ranks' average score falling above the normative threshold provided by Buysse and colleagues (1989). Analysis of Variance (ANOVA) performed found only the frequency of sleep disturbances (PSQIC5) to significantly differ between police officers based on their rank (p=0.002), with Tukey post-hoc identifying SR having a higher incidence than PC (p=0.001).

Table 6.28 – Mean overall sleep quality for probationary constables (n=57), constables (n=99), senior constables (n=53) and sergeants (n=46)

Global PSQI Score	PC (n=57)	C (n=99)	SC (n=53)	Sgt (n=46)
Overall Sleep Quality	6.70 ± 3.74	6.79 ± 3.57	6.94 ± 3.53	6.54 ± 3.61
Sleep Component	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**
Subjective Sleep Quality (PSQIC1)	1.23 ± 0.80	1.22 ± 0.79	1.21 ± 0.77	1.26 ± 0.83
Sleep Onset Latency (PSQIC2)	1.46 ± 1.02	1.39 ± 0.90	1.38 ± 1.10	1.09 ± 0.96
Sleep Duration (PSQIC3)	0.98 ± 0.92	0.81 ± 0.94	0.89 ± 0.87	1.11 ± 0.99
Sleep Efficiency (PSQIC4)	0.74 ± 0.97	0.82 ± 1.04	0.62 ± 0.95	0.61 ± 0.86
Sleep Disturbances (PSQIC5)*	1.04 ± 0.46	1.25 ± 0.56	1.43 ± 0.54	1.28 ± 0.54
Sleep Medication Usage (PSQIC6)	0.33 ± 0.81	0.24 ± 0.67	0.30 ± 0.61	0.11 ± 0.48
Daytime Dysfunction (PSQIC7)	0.93 ± 0.80	1.05 ± 0.84	1.11 ± 0.78	1.09 ± 0.91

Table 6.28 shows mean overall sleep quality for the PC, C, SC and Sgt (n=7, n=99, n=53 and n=46 respectively). Analysis of variance (ANOVA) was performed and only the frequency of sleep disturbances (PSQIC5) was found to be significantly different based on rank (p=0.002), with SR experiencing them more frequently than PC (p=0.001). The maximum score for the PSQI (overall sleep quality) is 21, with greater scores indicating a worse quality of sleep (Buysse et al., 1989). The global score is determined by summing the seven component values, which assess different facets of sleep, including subjective sleep quality, sleep onset latency, sleep duration, sleep efficiency, sleep disturbances, sleep medication usage and daytime dysfunction.

Key: C = Constable, PC = Probationary Constable, PSQIC = Pittsburgh Sleep Quality Index Component, SC = Senior Constable, Sgt = Sergeant; SD =Standard Deviation, ± = Plus and minus, * = Level of statistical significance (p<0.01)

Sleepiness and fatigue prevalence were also assessed for the various ranks of general duties police officers (Table 6.29). The mean sleepiness risk (ESS) and total fatigue impact (CIS20) for all ranks were below the normative threshold values (Johns, 1991; Vercoulen et al., 1994). By comparison, only C fatigue severity (FSS) score was found to fall above the threshold value (Krupp et al., 1989); however no significant differences were identified between police officers based on rank after performing ANOVA.

Table 6.29 – Mean sleepiness and fatigue scores for probationary constables (n=57), constables (n=99), senior constables (n=53) and sergeants (n=46)

Variable	PC (n=57)	C (n=99)	SC (n=53)	Sgt (n=46)
Sleepiness Risk (ESS)	6.47 ± 3.87	6.98 ± 3.65	7.38 ± 4.30	6.91 ± 4.96
Fatigue Severity (FSS)	33.48 ± 9.87	36.56 ± 10.37	35.82 ± 9.91	33.72 ± 11.62
Total Fatigue Impact (CIS20)	61.38 ± 18.10	65.15 ± 20.16	63.64 ± 16.94	61.93 ± 19.57
CIS20 Component	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Subjective Fatigue (CIS20-1)	25.90 ± 9.92	29.05 ± 10.60	5.65 ± 0.72	28.10 ± 10.88
Reduced Concentration (CIS20-2)	15.23 ± 4.30	16.47 ± 6.03	5.46 ± 0.64	14.10 ± 6.49
Reduced Motivation (CIS20-3)	12.03 ± 4.08	11.55 ± 4.20	28.04 ± 8.07	12.24 ± 4.60
Reduced Activity (CIS20-4)	8.23 ± 3.23	8.08 ± 3.76	16.14 ± 5.89	7.48 ± 3.94

Table 6.29 shows mean sleepiness risk, fatigue severity and total fatigue for the PC, C, SC and Sgt (n=7, n=99, n=53 and n=46 respectively). Analysis of variance (ANOVA) was performed and found no significant differences based on rank The maximum score for the ESS (sleepiness risk) is 24, with greater scores indicating a greater likelihood of dozing (Johns, 1991). The maximum score for the FSS (fatigue severity) is 63, with greater scores indicating a stronger severity of fatigue impact (Krupp et al., 1989). The maximum score for the CIS20 is determined by summing the four component values, which assess different aspects of fatigue, including subjective fatigue and reduced concentration, motivation and activity (Vercoulen et al., 1994).

Key: C = Constable, CIS20 = Checklist of Individual Strength, ESS = Epworth Sleepiness Scale, FSS = Fatigue Severity Scale, PC = Probationary Constable, SC = Senior Constable, Sgt = Sergeant; SD = Standard Deviation, ± = Plus and minus

6.1.4.2 Sleep Associations & Regression Analyses (rank comparison)

Pearson's correlations were performed to identify the relationship between police officers' sleepiness and fatigue with other independent variables depending on their rank. Where three or more independent variables were found to be significantly correlated with the dependant variable of stress perception, consequent multiple regressions were performed.

Sleepiness risk (ESS) was found to have a number of significant relationships with other independent variables when comparing between the ranks (Table 6.30). PC sleepiness risk was negatively correlated with their age ($r=-0.31$, $p=0.019$), and positively associated with perception of stress (LAQ Part 2) ($r=0.45$, $p<0.001$) and daytime dysfunction ($r=0.47$, $p<0.001$). A subsequent multiple regression (Table 6.31) was performed using the significant correlations identified and was found to be overall significant for sleepiness risk ($F(3,53) = 9.57$, $p<0.001$). Together the independent variables explain 35% of the variance in PC ranked officers' sleepiness risk, with age ($p=0.025$) and daytime dysfunction ($p=0.009$) being the significant predictors.

By comparison, C sleepiness risk was found to have the most significant positive correlations, including TTW ($r=0.27$, $p=0.035$), perception of stress ($r=0.35$, $p<0.001$) and the following components of the PSQI; subjective sleep quality ($r=0.25$, $p=0.013$), frequency of sleep disturbances ($r=0.26$, $p=0.009$) and daytime dysfunction ($r=0.39$, $p<0.001$), as well as global PSQI score ($r=0.26$, $p=0.008$). A subsequent multiple regression (Table 6.32) was performed using the significant correlations identified and was found to be overall significant for sleepiness risk ($F(6,54) = 3.06$, $p=0.012$). Together the independent variables explain 25% of the variance in C ranked officers' sleepiness risk, although none of the individual variables were found to be significant predictors.

SC sleepiness risk was also positively associated with TTW ($r=0.41$, $p=0.034$), perception of stress ($r=0.41$, $p=0.002$), subjective sleep quality ($r=0.41$, $p=0.003$), daytime dysfunction ($r=0.56$, $p<0.001$) and global PSQI score ($r=0.40$, $p=0.003$). A subsequent multiple regression (Table 6.33) was performed using the significant correlations identified and was found to be overall significant for sleepiness risk ($F(5,21) = 5.08$, $p=0.003$). Together the independent variables explain 55% of the variance in SC ranked officers' sleepiness risk, with only the variables of TTW ($p=0.009$) and daytime dysfunction ($p=0.012$) being the significant predictors.

Finally, Sgt sleepiness risk was positively correlated with a number of PSQI components; subjective sleep quality ($r=0.30$, $p=0.041$), sleep duration ($r=0.44$, $p=0.002$) and daytime dysfunction ($r=0.52$, $p<0.001$), as well as global PSQI score ($r=0.37$, $p=0.011$). A subsequent multiple regression (Table 6.34) was performed using the significant correlations identified and was found to be overall significant for sleepiness risk ($F(4,41) = 7.58$, $p<0.001$). Together the independent variables explain 43% of the variance in Sgt ranked officers' sleepiness risk, with sleep duration ($p=0.002$) and daytime dysfunction ($p<0.001$) being the significant predictors.

Table 6.30 – Significant correlations between independent variables and sleepiness risk for probationary constables (n=57), constables (n=99), senior constables (n=53) and sergeants (n=46)

Independent Variables	**Sleepiness Risk (ESS)**							
	PC (n=57)		**C (n=99)**		**SC (n=53)**		**Sgt (n=46)**	
	r	***p***	***r***	***p***	***r***	***p***	***r***	***p***
Years of Age	-0.31	**0.019**	-	-	-	-	-	-
TTW	-	-	0.27	**0.035**	0.41	**0.034**	-	-
Perception of Stress (LAQ Part 2)	0.45	**<0.001**	0.35	**<0.001**	0.41	**0.002**	-	-
Subjective Sleep Quality (PSQIC1)	-	-	0.25	**0.013**	0.41	**0.003**	0.30	**0.041**
Sleep Duration (PSQIC3)	-	-	-	-	-	-	0.44	**0.002**
Sleep Disturbances (PSQIC5)	-	-	0.26	**0.009**	-	-	-	-
Daytime Dysfunction (PSQIC7)	0.47	**<0.001**	0.39	**<0.001**	0.56	**<0.001**	0.52	**<0.001**
PSQI Global	-	-	0.26	**0.008**	0.40	**0.003**	0.37	**0.011**

Table 6.30 shows significant results from Pearson's correlations between sleepiness risk (ESS) and other independent variables for the PC, C, SC and Sgt (n=7, n=99, n=53 and n=46 respectively).

Key: C = Constable, ESS = Epworth Sleepiness Scale, LAQ = Lifestyle Appraisal Questionnaire, PC = Probationary Constable, PSQI = Pittsburgh Sleep Quality Index, SC = Senior Constable, Sgt = Sergeant, TTW = Total Travel Work Time; n=Sample size, p = Level of statistical significance (p=<0.05 (in bold))

Table 6.31 – Multiple regression between sleepiness risk and significantly correlated variables in probationary constables (n=57)

PC (n=57)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Sleepiness Risk (ESS)	0.59	0.35	0.32	3.21	**<0.001**
	B	**Std. Error**	**Beta**	**T**	**p**
(Constant)	8.76	2.80		3.13	**0.003**
Years of Age	-0.22	0.10	-0.26	-2.30	**0.025**
Perception of Stress (LAQ Part 2)	0.13	0.07	0.24	1.91	0.06
Daytime Dysfunction (PSQIC7)	1.67	0.61	0.34	2.73	**0.009**

Table 6.31 shows multiple regression analysis between sleepiness risk (ESS) and significant variables as determined by Pearson's correlations; years of age, perception of stress (LAQ Part 2) and daytime dysfunction (PSQIC7) for the probationary constables (n=99).

Key: ESS = Epworth Sleepiness Scale, LAQ = Lifestyle Appraisal Questionnaire, PC = Probationary Constable, PSQI = Pittsburgh Sleep Quality Index; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Table 6.32 – Multiple regression between sleepiness risk and significantly correlated variables in constables (n=99)

C (n=99)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Sleepiness Risk (ESS)	0.50	0.25	0.17	3.33	**0.012**
	B	**Std. Error**	**Beta**	**T**	**p**
(Constant)	3.29	1.19		2.76	**0.008**
TTW	0.00	0.00	0.26	1.81	0.08
Perception of Stress (LAQ Part 2)	0.11	0.05	0.30	2.14	0.037
Subjective Sleep Quality (PSQIC1)	-0.22	0.89	-0.05	-0.25	0.80
Sleep Disturbances (PSQIC5)	0.51	1.00	0.08	0.51	0.61
Daytime Dysfunction (PSQIC7)	1.18	0.65	0.27	1.82	0.07
PSQI Global	-0.13	0.21	-0.13	-0.64	0.53

Table 6.32 shows multiple regression analysis between sleepiness risk (ESS) and significant variables as determined by Pearson's correlations; TTW, perception of stress (LAQ Part 2), subjective sleep quality, frequency of sleep disturbances and daytime dysfunction (PSQI Components 1, 5 and 7 respectively), as well as global PSQI score for the constables (n=99).

Key: C = Constable, ESS = Epworth Sleepiness Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQI = Pittsburgh Sleep Quality Index, TTW = Total Travel Work Time; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Table 6.33 – Multiple regression between sleepiness risk and significantly correlated variables in senior constables (n=53)

SC (n=53)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Sleepiness Risk (ESS)	0.74	0.55	0.44	3.22	**0.003**
	B	**Std. Error**	**Beta**	**T**	**p**
(Constant)	0.40	1.72		0.23	0.82
TTW	0.01	0.00	0.46	2.88	**0.009**
Perception of Stress (LAQ Part 2)	0.02	0.08	0.04	0.20	0.85
Subjective Sleep Quality (PSQIC1)	0.25	1.22	0.04	0.20	0.84
Daytime Dysfunction (PSQIC7)	3.00	1.09	0.54	2.76	**0.012**
PSQI Global	0.07	0.28	0.06	0.26	0.80

Table 6.33 shows multiple regression analysis between sleepiness risk (ESS) and significant variables as determined by Pearson's correlations; TTW, perception of stress (LAQ Part 2), subjective sleep quality and daytime dysfunction (PSQI Components 1 and 7 respectively), as well as global PSQI score for the senior constables (n=53).

Key: ESS = Epworth Sleepiness Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQI = Pittsburgh Sleep Quality Index, SC = Senior Constable, TTW = Total Travel Work Time; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Table 6.34 – Multiple regression between sleepiness risk and significantly correlated variables in sergeants (n=46)

Sgt (n=46)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Sleepiness Risk (ESS)	0.65	0.43	0.37	3.94	**<0.001**
	B	**Std. Error**	**Beta**	**T**	**p**
(Constant)	4.54	1.24		3.65	**0.001**
Subjective Sleep Quality (PSQIC1)	1.11	1.61	0.19	0.69	0.49
Sleep Duration (PSQIC3)	3.05	0.92	0.61	3.31	**0.002**
Daytime Dysfunction (PSQIC7)	3.88	0.98	0.71	3.97	**<0.001**
PSQI Global	-1.01	0.52	-0.74	-1.95	0.06

Table 6.34 shows multiple regression analysis between sleepiness risk (ESS) and significant variables as determined by Pearson's correlations; subjective sleep quality, sleep duration and daytime dysfunction (PSQI Components 1, 3 and 7 respectively), as well as global PSQI score for the sergeants (n=46).

Key: ESS = Epworth Sleepiness Scale, PSQI = Pittsburgh Sleep Quality Index, Sgt = Sergeant; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Fatigue severity (FSS) was found to share a number of similar positive relationships with sleepiness risk when comparing between the ranks (Table 6.35). PC fatigue severity was positively associated with perception of stress ($r=0.35$, $p=0.029$), frequency of sleep disturbances ($r=0.46$, $p=0.003$), daytime dysfunction ($r=0.35$, $p=0.025$) and global PSQI score ($r=0.36$, $p=0.025$). A subsequent multiple regression (Table 6.36) was performed using the significant correlations identified and was found to be overall significant for fatigue severity ($F(4,35) = 3.22$, $p=0.024$). Together the independent variables explain 27% of the variance in PC ranked officers' fatigue severity, with only frequency of sleep disturbances ($p=0.047$) being a significant predictor.

By comparison, C fatigue severity was again found to have the most significant positive correlations, including perception of stress ($r=0.52$, $p<0.001$) and the following components of the PSQI; subjective sleep quality ($r=0.56$, $p<0.001$), sleep duration ($r=0.25$, $p=0.048$), frequency of sleep disturbances ($r=0.40$, $p=0.001$), sleep medication usage ($r=0.39$, $p=0.002$) and daytime dysfunction ($r=0.59$, $p<0.001$), as well as global PSQI score ($r=0.57$, $p<0.001$). A subsequent multiple regression (Table 6.37) was performed using the significant correlations identified and was found to be overall significant for fatigue severity ($F(7,54) = 9.48$, $p<0.001$). Together the independent variables explain 55% of the variance in C ranked officers' fatigue severity, with perception of stress ($p=0.019$), subjective sleep quality ($p=0.035$) and daytime dysfunction ($p=0.003$) being the significant predictors.

SC fatigue severity was also positively associated with perception of stress ($r=0.43$, $p=0.021$), sleep onset latency ($r=0.50$, $p=0.007$), frequency of sleep disturbances ($r=0.48$, $p=0.010$), daytime dysfunction ($r=0.70$, $p<0.001$) and global PSQI score ($r=0.55$, $p=0.003$). A subsequent multiple regression (Table 6.38) was performed using the significant correlations identified and was found to be overall significant for fatigue severity ($F(5,22) = 6.93$, $p=0.001$). Together the independent variables explain 61% of the variance in SC ranked officers' fatigue severity, with sleep onset latency ($p=0.044$) and daytime dysfunction ($p=0.004$) being the significant predictors.

Finally, Sgt fatigue severity was positively correlated with their perception of stress (r=0.51, p=0.004) and a number of PSQI components; subjective sleep quality (r=0.50, p=0.006), sleep onset latency (r=0.41, p=0.026), frequency of sleep disturbances (r=0.50, p=0.006) and daytime dysfunction (r=0.58, p=0.001), as well as global PSQI score (r=0.55, p=0.002). A subsequent multiple regression (Table 6.39) was performed using the significant correlations identified and was found to be overall significant for fatigue severity (F(6,22) = 3.14, p=0.022). Together the independent variables explain 46% of the variance in Sgt ranked officers' fatigue severity, although no individual variable was found to be a significant predictor.

Table 6.35 – Significant correlations between independent variables and fatigue severity for probationary constables (n=57), constables (n=99), senior constables (n=53) and sergeants (n=46)

Independent Variables	Fatigue Severity (FSS)							
	PC (n=57)		C (n=99)		SC (n=53)		Sgt (n=46)	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*
Perception of Stress (LAQ Part 2)	0.35	**0.029**	0.52	**<0.001**	0.43	**0.021**	0.51	**0.004**
Subjective Sleep Quality (PSQIC1)	-	-	0.56	**<0.001**	-	-	0.50	**0.006**
Sleep Onset Latency (PSQIC2)	-	-	-	-	0.50	**0.007**	0.41	**0.026**
Sleep Duration (PSQIC3)	-	-	0.25	**0.048**	-	-	-	-
Sleep Disturbances (PSQIC5)	0.46	**0.003**	0.40	**0.001**	0.48	**0.010**	0.50	**0.006**
Sleep Medication Usage (PSQIC6)	-	-	0.39	**0.002**	-	-	-	-
Daytime Dysfunction (PSQIC7)	0.35	**0.025**	0.59	**<0.001**	0.70	**<0.001**	0.58	**0.001**
PSQI Global	0.36	**0.025**	0.57	**<0.001**	0.55	**0.003**	0.55	**0.002**

Table 6.35 shows significant results from Pearson's correlations between fatigue severity (FSS) and other independent variables for the PC, C, SC and Sgt (n=7, n=99, n=53 and n=46 respectively).

Key: C = Constable, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PC = Probationary Constable, PSQI = Pittsburgh Sleep Quality Index, SC = Senior Constable, Sgt = Sergeant; n=Sample size, p = Level of statistical significance (p=<0.05 (in bold))

Table 6.36 – Multiple regression between fatigue severity and significantly correlated variables in probationary constables (n=57)

PC (n=57)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Fatigue Severity (FSS)	0.52	0.27	0.19	8.91	**0.024**
	B	**Std. Error**	**Beta**	**T**	**p**
(Constant)	20.70	4.06		5.10	**<0.001**
Perception of Stress (LAQ Part 2)	0.16	0.23	0.12	0.71	0.48
Sleep Disturbances (PSQIC5)	7.22	3.51	0.34	2.06	**0.047**
Daytime Dysfunction (PSQIC7)	1.31	2.36	0.11	0.56	0.58
PSQI Global	0.24	0.51	0.09	0.47	0.64

Table 6.36 shows multiple regression analysis between sleepiness risk (ESS) and significant variables as determined by Pearson's correlations; perception of stress (LAQ Part 2), frequency of sleep disturbances and daytime dysfunction (PSQI Components 5 and 7 respectively), as well as global PSQI score for the probationary constables (n=99).

Key: FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PC = Probationary Constable, PSQI = Pittsburgh Sleep Quality Index; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Table 6.37 – Multiple regression between fatigue severity and significantly correlated variables in constables (n=99)

C (n=99)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Fatigue Severity (FSS)	0.74	0.55	0.49	7.38	**<0.001**
	B	**Std. Error**	**Beta**	**T**	**p**
(Constant)	23.36	2.70		8.66	**<0.001**
Perception of Stress (LAQ Part 2)	0.25	0.10	0.25	2.42	**0.019**
Subjective Sleep Quality (PSQIC1)	4.29	1.99	0.33	2.16	**0.035**
Sleep Duration (PSQIC3)	1.68	1.62	0.15	1.04	0.31
Sleep Disturbances (PSQIC5)	0.21	2.34	0.01	0.09	0.93
Sleep Medication Usage (PSQIC6)	2.71	1.74	0.18	1.56	0.13
Daytime Dysfunction (PSQIC7)	5.03	1.60	0.41	3.16	**0.003**
PSQI Global	-0.58	0.75	-0.20	-0.77	0.44

Table 6.37 shows multiple regression analysis between sleepiness risk (ESS) and significant variables as determined by Pearson's correlations; perception of stress (LAQ Part 2), subjective sleep quality, sleep duration, frequency of sleep disturbances, sleep medication usage and daytime dysfunction (PSQI Components 1, 3, 5, 6 and 7 respectively), as well as global PSQI score for the constables (n=99).

Key: C = Constable, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQI = Pittsburgh Sleep Quality Index; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Table 6.38 – Multiple regression between fatigue severity and significantly correlated variables in senior constables (n=53)

SC (n=53)	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**p**
Fatigue Severity (FSS)	0.78	0.61	0.52	6.84	**0.001**
	B	**Std. Error**	**Beta**	**t**	**p**
(Constant)	20.50	3.87		5.30	**<0.001**
Perception of Stress (LAQ Part 2)	0.08	0.16	0.08	0.51	0.62
Sleep Onset Latency (PSQIC2)	4.17	1.96	0.46	2.13	**0.044**
Sleep Disturbances (PSQIC5)	4.23	3.28	0.23	1.29	0.21
Daytime Dysfunction (PSQIC7)	7.33	2.28	0.57	3.21	**0.004**
PSQI Global	-0.84	0.77	-0.30	-1.09	0.29

Table 6.38 shows multiple regression analysis between sleepiness risk (ESS) and significant variables as determined by Pearson's correlations; perception of stress (LAQ Part 2), sleep onset latency, frequency of sleep disturbances and daytime dysfunction (PSQI Components 2, 5 and 7 respectively), as well as global PSQI score for the senior constables (n=53).

Key: FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQI = Pittsburgh Sleep Quality Index, SC = Senior Constable; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Table 6.39 – Multiple regression between fatigue severity and significantly correlated variables in sergeants (n=46)

Sgt (n=46)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Fatigue Severity (FSS)	0.68	0.46	0.32	9.62	**0.022**
	B	**Std. Error**	**Beta**	**T**	**p**
(Constant)	18.72	4.91		3.82	**0.001**
Perception of Stress (LAQ Part 2)	0.25	0.35	0.17	0.73	0.47
Subjective Sleep Quality (PSQIC1)	3.93	5.18	0.28	0.76	0.46
Sleep Onset Latency (PSQIC2)	3.02	2.52	0.25	1.20	0.24
Sleep Disturbances (PSQIC5)	5.04	4.71	0.24	1.07	0.30
Daytime Dysfunction (PSQIC7)	5.47	3.02	0.43	1.81	0.08
PSQI Global	-1.37	1.63	-0.43	-0.84	0.41

Table 6.39 shows multiple regression analysis between sleepiness risk (ESS) and significant variables as determined by Pearson's correlations; perception of stress (LAQ Part 2), subjective sleep quality, sleep onset latency, frequency of sleep disturbances and daytime dysfunction (PSQI Components 1, 2, 5 and 7 respectively), as well as global PSQI score for the sergeants (n=46).

Key: FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQI = Pittsburgh Sleep Quality Index, Sgt = Sergeant; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Finally, total fatigue impact (CIS20) (Table 6.40) was found to have a number of significant associations when comparing between the ranks. PC total fatigue impact was positively associated with lifestyle risk factors ($r=0.59$, $p<0.001$), perception of stress ($r=0.68$, $p<0.001$) and the following components of the PSQI; subjective sleep quality ($r=0.68$, $p<0.001$), sleep duration ($r=0.37$, $p=0.020$), sleep efficiency ($r=0.41$, $p=0.009$), frequency of sleep disturbances ($r=0.39$, $p=0.012$), sleep medication usage ($r=0.47$, $p=0.002$) and daytime dysfunction ($r=0.64$, $p<0.001$), as well as global PSQI score ($r=0.79$, $p<0.001$). A subsequent multiple regression (Table 6.41) was performed using the significant correlations identified and was found to be overall significant for total fatigue impact ($F(9,30) = 12.25$, $p<0.001$). Together the independent variables explain 79% of the variance in PC ranked officers' total fatigue impact, with lifestyle risk factors ($p=0.044$) and perception of stress ($p=0.021$) being the significant predictors.

By comparison, C total fatigue impact was found to have a number of similar significant positive correlations with PC, including lifestyle risk factors ($r=0.31$, $p=0.013$), perception of stress ($r=0.71$, $p<0.001$) and the following PSQI components; subjective sleep quality ($r=0.50$, $p<0.001$), sleep onset latency ($r=0.38$, $p=0.002$), frequency of sleep disturbances ($r=0.40$, $p=0.001$) and daytime dysfunction ($r=0.39$, $p=0.002$), as well as global PSQI score ($r=0.51$, $p<0.001$). A subsequent multiple regression (Table 6.42) was performed using the significant correlations identified and was found to be overall significant for total fatigue impact ($F(7,54) = 11.18$, $p<0.001$). Together the independent variables explain 59% of the variance in C ranked officers' total fatigue impact, with the only variable of perception of stress ($p<0.001$) being a significant predictor.

SC total fatigue impact was also positively associated with lifestyle risk factors ($r=0.56$, $p=0.002$), perception of stress ($r=0.62$, $p<0.001$) and the following components of the PSQI; subjective sleep quality ($r=0.44$, $p=0.019$), sleep onset latency ($r=0.47$, $p=0.011$), sleep medication usage ($r=0.42$, $p=0.026$) and daytime dysfunction ($r=0.59$, $p=0.001$), as well as global PSQI score ($r=0.62$, $p<0.001$). A subsequent multiple regression (Table 6.43) was performed using the significant correlations identified and was found to be overall significant for total fatigue impact ($F(7,20) = 19.19$, $p<0.001$). Together the independent variables explain 87% of the variance in SC ranked officers' total fatigue impact, with lifestyle risk factors ($p=0.008$), perception of stress ($p=0.002$), sleep onset latency ($p=0.007$), sleep medication usage ($p<0.001$) and daytime dysfunction ($p<0.001$) being the significant predictors.

Finally, Sgt total fatigue impact was positively correlated with their lifestyle risk factors ($r=0.48$, $p=0.009$), perception of stress ($r=0.76$, $p<0.001$) and the following PSQI components; subjective sleep quality ($r=0.57$, $p=0.001$), sleep onset latency ($r=0.50$, $p=0.006$), sleep duration ($r=0.63$, $p<0.001$), frequency of sleep disturbances ($r=0.52$, $p=0.004$) and daytime dysfunction ($r=0.67$, $p<0.001$), as well as global PSQI score ($r=0.71$, $p<0.001$). A subsequent multiple regression (Table 6.44) was performed using the significant correlations identified and was found to be overall significant for total fatigue impact ($F(8,20) = 17.41$, $p<0.001$). Together the independent variables explain 87% of the variance in Sgt ranked officers' total fatigue impact, with perception of stress ($p=0.001$), sleep onset latency ($p=0.001$), sleep duration ($p<0.001$), daytime dysfunction ($p<0.001$) and global PSQI score ($p=0.001$) being the significant predictors.

Table 6.40 – Significant correlations between independent variables and total fatigue impact for probationary constables (n=57), constables (n=99), senior constables (n=53) and sergeants (n=46)

Independent Variables	Total Fatigue Impact (CIS20)							
	PC (n=57)		C (n=99)		SC (n=53)		Sgt (n=46)	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*
Lifestyle Risk Factors (LAQ Part 1)	0.59	**<0.001**	0.31	**0.013**	0.56	**0.002**	0.48	**0.009**
Perception of Stress (LAQ Part 2)	0.68	**<0.001**	0.71	**<0.001**	0.62	**<0.001**	0.76	**<0.001**
Subjective Sleep Quality (PSQIC1)	0.68	**<0.001**	0.50	**<0.001**	0.44	**0.019**	0.57	**0.001**
Sleep Onset Latency (PSQIC2)	-	-	0.38	**0.002**	0.47	**0.011**	0.50	**0.006**
Sleep Duration (PSQIC3)	0.37	**0.020**	-	-	-	-	0.63	**<0.001**
Sleep Efficiency (PSQIC4)	0.41	**0.009**	-	-	-	-	-	-
Sleep Disturbances (PSQIC5)	0.39	**0.012**	0.40	**0.001**	-	-	0.52	**0.004**
Sleep Medication Usage (PSQIC6)	0.47	**0.002**	-	-	0.42	**0.026**	-	-
Daytime Dysfunction (PSQIC7)	0.64	**<0.001**	0.39	**0.002**	0.59	**0.001**	0.67	**<0.001**
PSQI Global	0.79	**<0.001**	0.51	**<0.001**	0.62	**<0.001**	0.71	**<0.001**

Table 6.40 shows significant results from Pearson's correlations between total fatigue impact (CIS20) and other independent variables for the PC, C, SC and Sgt (n=7, n=99, n=53 and n=46 respectively).

Key: C = Constable, CIS20 = Checklist of Individual Strength, LAQ = Lifestyle Appraisal Questionnaire, PC = Probationary Constable, PSQI = Pittsburgh Sleep Quality Index, SC = Senior Constable, Sgt = Sergeant; n=Sample size, p = Level of statistical significance (p=<0.05 (in bold))

Table 6.41 – Multiple regression between total fatigue impact and significantly correlated variables in probationary constables (n=57)

PC (n=57)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Total Fatigue Impact (CIS20)	0.89	0.79	0.72	9.55	**<0.001**
	B	Std. Error	Beta	T	p
(Constant)	24.73	5.22		4.73	**<0.001**
Lifestyle Risk Factors (LAQ Part 1)	0.76	0.36	0.23	2.10	**0.044**
Perception of Stress (LAQ Part 2)	0.66	0.27	0.27	2.43	**0.021**
Subjective Sleep Quality (PSQIC1)	3.81	4.29	0.17	0.89	0.38
Sleep Duration (PSQIC3)	1.66	3.06	0.08	0.54	0.59
Sleep Efficiency (PSQIC4)	2.41	3.46	0.13	0.70	0.49
Sleep Disturbances (PSQIC5)	3.91	4.48	0.10	0.87	0.39
Sleep Medication Usage (PSQIC6)	4.77	3.72	0.21	1.28	0.21
Daytime Dysfunction (PSQIC7)	6.21	3.61	0.27	1.72	0.10
PSQI Global	-0.26	2.32	-0.05	-0.11	0.91

Table 6.41 shows multiple regression analysis between sleepiness risk (ESS) and significant variables as determined by Pearson's correlations; lifestyle risk factors (LAQ Part 1), perception of stress (LAQ Part 2), subjective sleep quality, sleep onset latency, sleep duration, sleep efficiency, frequency of sleep disturbances, sleep medication usage and daytime dysfunction (PSQI Components 1 - 7 respectively), as well as global PSQI score for the probationary constables (n=99).

Key: CIS20 = Checklist of Individual Strength, LAQ = Lifestyle Appraisal Questionnaire, PC = Probationary Constable, PSQI = Pittsburgh Sleep Quality Index; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Table 6.42 – Multiple regression between total fatigue impact and significantly correlated variables in constables (n=99)

C (n=99)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Total Fatigue Impact (CIS20)	0.77	0.59	0.54	13.69	**<0.001**
	B	Std. Error	Beta	T	P
(Constant)	31.43	5.61		5.60	**<0.001**
Lifestyle Risk Factors (LAQ Part 1)	0.09	0.37	0.02	0.23	0.82
Perception of Stress (LAQ Part 2)	1.10	0.20	0.57	5.56	**<0.001**
Subjective Sleep Quality (PSQIC1)	3.38	3.60	0.13	0.94	0.35
Sleep Onset Latency (PSQIC2)	3.14	2.60	0.14	1.21	0.23
Sleep Disturbances (PSQIC5)	1.82	4.16	0.05	0.44	0.66
Daytime Dysfunction (PSQIC7)	0.79	2.70	0.03	0.29	0.77
PSQI Global	0.30	1.07	0.05	0.28	0.78

Table 6.42 shows multiple regression analysis between sleepiness risk (ESS) and significant variables as determined by Pearson's correlations; lifestyle risk factors (LAQ Part 1), perception of stress (LAQ Part 2), subjective sleep quality, sleep onset latency, frequency of sleep disturbances and daytime dysfunction (PSQI Components 1, 2, 5 and 7 respectively), as well as global PSQI score for the constables (n=99).

Key: C = Constable, CIS20 = Checklist of Individual Strength, LAQ = Lifestyle Appraisal Questionnaire, PSQI = Pittsburgh Sleep Quality Index; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Table 6.43 – Multiple regression between total fatigue impact and significantly correlated variables in senior constables (n=53)

SC (n=53)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Total Fatigue Impact (CIS20)	0.93	0.87	0.83	7.09	**<0.001**
	B	Std. Error	Beta	T	P
(Constant)	32.13	3.68		8.73	**<0.001**
Lifestyle Risk Factors (LAQ Part 1)	0.75	0.26	0.28	2.92	**0.008**
Perception of Stress (LAQ Part 2)	0.62	0.18	0.35	3.48	**0.002**
Subjective Sleep Quality (PSQIC1)	-0.15	2.78	-0.01	-0.05	0.96
Sleep Onset Latency (PSQIC2)	6.47	2.15	0.42	3.01	**0.007**
Sleep Medication Usage (PSQIC6)	16.05	2.77	0.58	5.80	**<0.001**
Daytime Dysfunction (PSQIC7)	11.85	2.68	0.54	4.43	**<0.001**
PSQI Global	-2.05	1.04	-0.43	-1.96	0.06

Table 6.43 shows multiple regression analysis between sleepiness risk (ESS) and significant variables as determined by Pearson's correlations; lifestyle risk factors (LAQ Part 1), perception of stress (LAQ Part 2), subjective sleep quality, sleep onset latency, sleep medication usage and daytime dysfunction (PSQI Components 1, 2, 6 and 7 respectively), as well as global PSQI score for the senior constables (n=53).

Key: CIS20 = Checklist of Individual Strength, LAQ = Lifestyle Appraisal Questionnaire, PSQI = Pittsburgh Sleep Quality Index, SC = Senior Constable; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

Table 6.44 – Multiple regression between total fatigue impact and significantly correlated variables in sergeants (n=46)

Sgt (n=46)	R	R Square	Adjusted R Square	Std. Error of the Estimate	p
Total Fatigue Impact (CIS20)	0.94	0.87	0.82	9.63	**<0.001**
	B	Std. Error	Beta	T	P
(Constant)	24.41	5.66		4.31	**<0.001**
Lifestyle Risk Factors (LAQ Part 1)	0.33	0.32	0.09	1.02	0.32
Perception of Stress (LAQ Part 2)	1.43	0.35	0.48	4.09	**0.001**
Subjective Sleep Quality (PSQIC1)	11.60	5.59	0.42	2.07	0.05
Sleep Onset Latency (PSQIC2)	11.50	3.01	0.48	3.82	**0.001**
Sleep Duration (PSQIC3)	18.18	3.51	0.79	5.17	**<0.001**
Sleep Disturbances (PSQIC5)	6.92	4.94	0.16	1.40	0.18
Daytime Dysfunction (PSQIC7)	15.45	3.48	0.62	4.44	**<0.001**
PSQI Global	-9.07	2.39	-1.42	-3.79	**0.001**

Table 6.44 shows multiple regression analysis between sleepiness risk (ESS) and significant variables as determined by Pearson's correlations; lifestyle risk factors (LAQ Part 1), perception of stress (LAQ Part 2), subjective sleep quality, sleep onset latency, sleep duration, frequency of sleep disturbances and daytime dysfunction (PSQI Components 1, 2, 3, 5 and 7 respectively), as well as global PSQI score for the sergeants (n=46).

Key: CIS20 = Checklist of Individual Strength, LAQ = Lifestyle Appraisal Questionnaire, PSQI = Pittsburgh Sleep Quality Index, Sgt = Sergeant; B = Unstandardised regression coefficient, Beta = Standardised coefficient, n=Sample size, p = Level of statistical significance (p=<0.05 (in bold)), R = Multiple correlation coefficient, R square = Proportion of variance, Std. = Standard, t = t statistic, < = Less than

6.2 Discussion: Sleep and Shift Work

This chapter discusses findings with respect to general duties police officers' sleep quality, fatigue and shift work. It examines the significant relationships, before also addressing the differences between the identified comparative groups of sex (males vs. females), shift (day vs. night) and occupational rank (probationary constables, constables, senior constables and sergeants).

6.2.1 Sleep and Shift Work (total sample)

In the total sample of general duties police officers assessed, their mean overall sleep quality (PSQI) was found to be above the normative threshold score (Buysse et al., 1989). Almost 69% of subjects assessed were found to have poor sleep quality, and the significant positive associations found with sleepiness and fatigue are not a novel finding within shift working police populations. Similar studies also utilising the PSQI have reported poor sleep quality to predominate within their samples (Shao et al., 2010; Fekedulegn et al., 2014; Chang et al., 2015), ranging from 52.3 – 79%, suggesting it may in part be attributable to the inherent stressors of the occupation (Neylan et al., 2002) and prevalence of 'moonlighting' (Senjo, 2011). Secondary employment is unlikely a strong influence within this population, as approximately only 7-17% are approved according to most recent estimates within the NSW Police Force (Achterstraat, 2007). Stress by comparison may be a more likely contributor (Lin et al., 2014); this is also evidenced by the shared positive correlations found with the sleepiness and fatigue measures employed, often being found as a most significant predictor upon subsequent multiple regression analysis. The complex, bi-directional relationship between the SNS, HPA axis and diurnal sleep/wake cycle is well established (Steiger, 2002; Buckley & Schatzberg, 2005; Meerlo et al., 2008), and results in police officers being at a far greater risk of sleepiness and fatigue (Charles et al., 2011).

Based on the predominating poor sleep quality within this sample of police officers, it was unsurprising how both their subjective fatigue (CIS20) and fatigue severity (FSS) scores were above normative thresholds (Krupp et al., 1989; Vercoulen et al., 1994), found to be approximately 54% and 49% respectively. Fatigue is an established concern for police populations (Vila & Kenney, 2002; Vila, 2006), with recent studies reporting similar proportions of severe fatigue (Stępka & Basinska, 2014; Yadav et al., 2016). By comparison another study reported only 25% of police officers assessed were found to be at risk of excessive sleepiness based on normative scores (Johns, 1991), with similar prevalence noted among large samples of shift working police officers (n=4,957) (Rajaratnam et al., 2011). Since police officers were requested to complete the questionnaire battery at their discretion during regular shift hours, the time at which they completed it may have influenced their subjective perception, with authors suggesting sleepiness varies across a twelve hour shift (Tucker et al., 1998; Sallinen & Kecklund, 2010). However, current research suggests sleepiness and fatigue must be considered as separate and distinct (Pigeon et al., 2003; Shen et al., 2006), noting their independent manifestation in different sleep disorders (Hossain et al., 2003; Hossain et al., 2005) and advise the incorporation of more objective measures to distinguish between the two conditions (Shahid et al., 2010). Therefore, it would appear sleepiness is less of a concern within this cohort than their predominating fatigue. This has been found to place police officers at a far greater risk of accident and injury (Van Dijk & Swaen, 2003; Violanti et al., 2012) which may compromise public safety and lead to serious civil liability costs (Senjo, 2011).

There is abundant evidence in the available literature showing poor sleep quality, sleepiness and fatigue to predominate within shift working populations of various occupations (Åhsberg et al., 2000; Gerber, Hartmann, et al., 2010; Kazemi et al., 2016), 10% of whom may manifest Shift Work Sleep Disorder (Drake et al., 2004). While the concept of interindividual differences in tolerance to shift work persist (Oginska et al., 1993; Lammers-van der Holst & Kerkhof, 2015), and the determination of individuals' inclination towards "morningness vs. eveningness" (Torsvall & Åkerstedt, 1980; Härmä, 1995; Marcoen et al., 2015), it was not assessed within this sample and limits the ability to comment on its potential influence. The ergonomic risks of the 'flexible rostering guidelines' implemented by the NSW Police Force (Lauer, 1995) themselves must also be considered when discussing their officers' sleep health (Knauth, 1993). Overall, the rapidly-rotating, clockwise orientation of their regular shift system is preferable based on available literature (Barton & Folkard, 1993; Barton et al., 1994; Eriksen & Kecklund, 2007; Waggoner et al., 2012; Ferri et al., 2016), although improvements could be made with respect to the speed of return between successive shifts (Eldevik et al., 2013; Kim et al., 2015; Vedaa et al., 2016) and placement of rest days (Tucker et al., 1999; Karlson et al., 2009). Contention exists within the literature with respect to the 12-hour shift length employed by the NSW Police Force (Achterstraat, 2007); while some studies note a greater prevalence of sleepiness and fatigue associated with shift lengths of greater than ten hours (Tucker et al., 1998; Amendola et al., 2011; Kazemi et al., 2016), other authors have found no change or even improvements in overall sleep quality when changing from eight to 12-hour shifts (Peacock et al., 1983; Sallinen & Kecklund, 2010). If implemented cautiously, while considering the inherent risks associated with working longer periods at night (Rosa, 1995), there is also the added benefit from longer rest periods to mitigate some of the time constraints on familial obligations associated with shift work (Driscoll et al., 2007). Finally, the anecdotal preference for 12-hour shifts among shift workers should not be discounted either (Peacock et al., 1983; Loudoun, 2008).

The likely cause of this police samples' poor sleep quality and fatigue prevalence are the deleterious effects shift work has been shown to have by disrupting employees' natural sleep/wake cycle (Åkerstedt, 2003; Boivin & Boudreau, 2014). The combination of prolonged physical activity at night, along with exposure to artificial light sources and irregular feeding times (Åkerstedt & Wright, 2009), leads to desynchronization from the body's endogenous circadian rhythms (Scheer et al., 2009). The healthy diurnal fluctuations in catecholamines and neurobehavioural hormones (Driscoll et al., 2007; Arendt, 2010), such as cortisol and melatonin, will be severely compromised by the cumulative sleep deprivation (Harrison & Horne, 2000; Meerlo et al., 2008), resulting in the increase incidence of morbidity and mortality found among shift workers (Brum et al., 2015; Guo et al., 2015). The insidious ramifications of shift work may be further compounded by the potentially hazardous occupation of policing (Violanti et al., 2012); while there is no ideal roster system (Eriksen & Kecklund, 2007), there are steps that can be taken by the NSW Police Force to improve officers' sleep health while operating under unavoidable shift work (Knauth, 1993). Ensuring at least eleven hours between successive shifts for sufficient recuperation (Harrington, 2001; Eldevik et al., 2013), as well as education programmes on healthy sleep habits and recognising the symptoms of fatigue during critical times of vulnerability (Dinges, 1995). Although some authors propose pharmacological interventions may be suitable to improve both alertness at work and healthy sleep/wake cycles at rest (Åkerstedt & Wright, 2009), they often are not found to be as effective in the long term and may mask underlying pathologies (Proctor &

Bianchi, 2012; Liira et al., 2015). Finally, the implementation of napping strategies have been found to ameliorate some of the sleepiness and fatigue associated with shift work (Gillberg et al., 1996; Humm, 2008; Davy & Gobel, 2013), however care must be taken when considering the length of nap and potential risk of 'sleep inertia' (Muzet et al., 1995; Smith et al., 2007). Poor sleep quality and fatigue remain concerns for this sample of shift working general duties police officers; with further research and incorporation of these proposed recommendations, there will be overall improvements in the sleep and physiological health of the NSW Police Force.

6.2.2 Sleep and Shift Work (comparisons)

This section focuses on the differences which exist between the established sub-groups of sex (male vs. female), shift (day vs. night) and rank (probationary constable, constable, senior constable and sergeants). As such, the majority of the discussions with respect to sleep, fatigue and shift work already presented will not be repeated again.

6.2.2.1 Sleep: Impact of sex

Within this sample of general duties police officers, their overall sleep quality (PSQI), sleepiness risk (ESS) and fatigue burden (FSS & CIS20) did not differ when comparing between the sexes. Although similar results have been reported by other studies (Gerber, Hartmann, et al., 2010), noting the increased prevalence of snoring and sleep apnoea among males, some authors have found female shift workers to report worse deterioration of sleep quality (Åhsberg et al., 2000). Others have reported a greater fatigue severity and time required to recover among female shift workers (Eek et al., 2012), attributing the difference to the additional burden of child rearing and domestic responsibilities cemented in traditional gender roles (Härmä, 1995). Despite this, a number of significant correlations were found to present for only female officers, and this must be explored further. While the majority of significant positive relationships found for both sexes with respect to sleep, fatigue and stress have been discussed already (see Section 6.2.1), it would appear younger and fitter female officers have a greater risk of sleepiness according to the inverse association identified with age and WHR. Further, there was a significant positive correlation between female's TTW with both their sleepiness risk and fatigue severity. While understandable, due to the way longer travelling periods to and from work have been shown to extend an already lengthy 12-hour shift (Moore-Ede et al., 2010), it was surprising that the correlation did not also present in male's since their TTW was not found to be significantly different (see Section 4.1.2.2). While there is evidence that males and females exhibit differences in sleep patterns and circulating sex hormones (Mong & Cusmano, 2016), it would appear that the depreciating effects of shift work on sleep and fatigue levels did not discriminate by sex among this sample. Both male and female police officers had predominating poor sleep quality and high fatigue severity that must be addressed to ensure their ongoing occupational health and safety while operating under a shift work roster system.

6.2.2.2 Sleep: Impact of shift

When comparing between police officers in this sample who were working either a day or night shift at time of assessment, no significant differences were found for their sleep quality, sleepiness risk and overall fatigue. However, those subjects working during the day were found to report significantly more reduced concentration (CIS20) than their peers working at night. These findings were unexpected, as the majority of the literature concludes that those working shifts at night experience worse sleep quality and higher levels of fatigue (Åhsberg et al., 2000; Fekedulegn et al., 2014). This is due to the obvious consequences of continuing physical and mental activity during the circadian nadir (Åkerstedt & Wright, 2009; Jermendy et al., 2012), although it is difficult to apply the findings of available literature as the majority explore the differences between fixed day and rotating shift workers (Driscoll et al., 2007; Gerber, Hartmann, et al., 2010; Yuan et al., 2011; Ferri et al., 2016; Roskoden et al., 2017). The sample assessed were all working under their shared 12-hour roster system (Achterstraat, 2007), and hence the correlations found may be due to select differences in the sleep/wake cycle in preparation for a day or night shift. For example, the early time of awakening required for a day shift has been found to precipitate sleepiness during rest days (Kecklund & Åkerstedt, 1993), while those working a night shift often spend over double the time awake if they rise at their regular awakening times compared to day staff (Åkerstedt, 2003). To combat this, many shift workers undertake prophylactic naps before their first night shift (Bonnet & Arand, 1994; Takahashi, 2003), and this habit of 'sleep banking' may be employed by this sample and explain the absence of some expected differences. Finally, crime rates also differ by time of day (Felson & Poulsen, 2003; Gottfredson & Soulé, 2004), so the differences observed may come down to which activities were undertaken during the respective day or night shift (Ma et al., 2015; Vasquez-Trespalacios et al., 2016), as well as whether it was their first or second day/night shift in their roster (Ramey et al., 2012), both of which unfortunately were not recorded in this study. Overall, similar to the findings with regards to sex differences, police officers working during a day or night shift both exhibited alarmingly poor sleep quality and levels of fatigue that require attention to ameliorate.

6.2.2.3 Sleep: Impact of rank

Comparisons were also made between general duties police officers' based on their occupational rank, and it was found that neither their sleepiness nor their fatigue measures differed significantly. Similarly, their overall sleep quality was not found to differ by rank (Charles et al., 2011), however SC were found the experience significantly more sleep disturbances (PSQI) than PC. This is likely attributable to their age differences and greater likelihood of responsibilities in a family context (Harrington, 2001; Gerber, Hartmann, et al., 2010). The majority of associations found were shared by all ranks, however age was again found to be a novel association with PC's sleepiness risk, where younger officers were found to be at a greater risk. Age was found to significantly differ between all ranks (see Section 4.1.4.1), and it has been established that aging has a large impact on human's overall sleep quality and quantity. Shortening sleep periods, alterations in brain rhythms at rest and a weakening of endogenous circadian rhythms (Van Dongen, 2006; Mander et al., 2017), attributable to changes in the sensitivity of the suprachiasmatic nucleus (Bliwise, 1999), are all a natural part of aging. For these reasons, it is unusual that the higher ranks of police officers assessed did not report worse sleep quality or fatigue severity, as it is known to be more difficult to continue shift work as one ages (Costa & Di Milia, 2008; Pires et al., 2009). However, the absence of these expected differences may be due to learned coping mechanisms of 'sleep banking' and perhaps the prophylactic naps undertaken by some senior officers (Bonnet & Arand, 1994; Takahashi, 2003). Since poor sleep quality and fatigue severity appears to predominate in this sample of police officers regardless of rank, interventions must be implemented to adequately address the issues at all levels to ensure officer and public safety while operating under a shift work roster system.

6.3 Conclusion: Sleep and Shift Work

The current study identified a number of significant associations between sleepiness, fatigue and independent variables among shift working police officers, as well as differences based on their sex, shift and occupational rank. The propensity for shift work to disrupt healthy sleep-wake cycles leading to subsequent fatigue and sleepiness has been heavily documented (Shen et al., 2006; Åkerstedt & Wright, 2009; Yuan et al., 2011; Kazemi et al., 2016), and this was reflected in this study's findings. Primarily due to desynchronisation from the body's endogenous circadian rhythms, the predominating poor sleep quality (PSQI) and severe fatigue symptomology (FSS) observed among this sample remains a concern. Further, this appears to manifest equally among almost all subgroups assessed. By comparison, sleepiness (ESS) did not seem to impact this sample too greatly, and this was justified by literature that has sought to separate its existence with fatigue (Pigeon et al., 2003; Hossain et al., 2005). Finally, significant correlations were found with sleepiness risk, fatigue severity and total fatigue impact (CIS20), where the majority of findings conformed to similar research highlighting the relationship with poor sleep quality. There is an obvious need for novel interventions to manage overall sleep health and fatigue prevalence among shift working populations, potentially via education and/or napping schedules. Future research with the NSW Police Force could assess the efficacy of programmes seeking to ameliorate fatigue, thereby reducing potential accidents and improving the occupational safety of police officers employed under a shift work roster system. Refer to Table 6.45, 6.46, 6.47 and 6.48 for a summary of the significant associations between sleep factors and independent variables for each sample.

Table 6.45 – Summary of significant partial correlations between sleepiness, fatigue and independent variables for the total sample (N=255)

	Independent Variables	Sleepiness Risk (ESS)	Fatigue Severity (FSS)	Total Fatigue Impact (CIS20)
Total Sample (N=255)	WHR	-		
	TTW	+		
	Lifestyle Risk Factors (LAQ Part 1)			+
	Perception of Stress (LAQ Part 2)	+	+	+
	Subjective Sleep Quality (PSQIC1)	+	+	+
	Sleep Duration (PSQIC3)	+	+	+
	Sleep Efficiency (PSQIC4)	+	+	+
	Sleep Disturbances (PSQIC5)	+	+	+
	Sleep Medication Usage (PSQIC6)		+	+
	Daytime Dysfunction (PSQIC7)	+	+	+
	PSQI Global	+	+	+

Table 6.45 summarises the significant Pearson's correlations between sleep factors and other variables from the LAQ and PSQI for the total sample (N=255).

Key: CIS20 = Checklist of Individual Strength, ESS = Epworth Sleepiness Scale, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, TTW = Total Travel Work Time, WHR = Waist-Hip Ratio; + = Positive correlation; - = Negative correlation

Table 6.46 – Summary of significant partial correlations between sleepiness, fatigue and independent variables for male (n=179) and female (n=76) police officers

	Independent Variables	Sleepiness Risk (ESS)	Fatigue Severity (FSS)	Total Fatigue Impact (CIS20)
Male (n=179) vs. Female (n=76) Police Officers	Years of Age	-		
	WHR	-		
	TTW	+	+	
	Lifestyle Risk Factors (LAQ Part 1)			+
	Perception of Stress (LAQ Part 2)	+ / +	+ / +	+
	Subjective Sleep Quality (PSQIC1)	+ / +	+ / +	+
	Sleep Onset Latency (PSQIC2)		+	+
	Sleep Duration (PSQIC3)	+	+	
	Sleep Disturbances (PSQIC5)	+	+ / +	+
	Sleep Medication Usage (PSQIC6)		+	+
	Daytime Dysfunction (PSQIC7)	+ / +	+ / +	+
	PSQI Global	+ / +	+ / +	+

Table 6.46 summarises the significant Pearson's correlations between sleep factors and other variables from the LAQ and PSQI for the male (shown in black) (n=179) and female (shown in red) police officers.

Key: CIS20 = Checklist of Individual Strength, ESS = Epworth Sleepiness Scale, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, TTW = Total Travel Work Time, WHR = Waist-Hip Ratio; + = Positive correlation; - = Negative correlation

Table 6.47 – Summary of significant partial correlations between sleepiness, fatigue and independent variables for police officers working a day (n=148) or night shift (n=107)

Day (n=148) vs. Night Shift (n=107) Police Officers	Independent Variables	Sleepiness Risk (ESS)	Fatigue Severity (FSS)	Total Fatigue Impact (CIS20)
	TTW	+		
	Lifestyle Risk Factors (LAQ Part 1)			+ / +
	Perception of Stress (LAQ Part 2)	+ / +	+ / +	+ / +
	Subjective Sleep Quality (PSQIC1)	+ / +	+ / +	+ / +
	Sleep Onset Latency (PSQIC2)		+ / +	+ / +
	Sleep Duration (PSQIC3)		+	+ / +
	Sleep Efficiency (PSQIC4)		+	+
	Sleep Disturbances (PSQIC5)	+ / +	+ / +	+ / +
	Sleep Medication Usage (PSQIC6)		+	+ / +
	Daytime Dysfunction (PSQIC7)	+ / +	+ / +	+ / +
	PSQI Global	+ / +	+ / +	+ / +

Table 6.47 summarises the significant Pearson's correlations between sleep factors and other variables from the LAQ and PSQI for the day (shown in black) (n=148) and night shift (shown in red) (n=107) police officers.

Key: CIS20 = Checklist of Individual Strength, ESS = Epworth Sleepiness Scale, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PSQIC = Pittsburgh Sleep Quality Index Component, TTW = Total Travel Work Time; + = Positive correlation

Table 6.48 – Summary of significant partial correlations between sleepiness, fatigue and independent variables for probationary constables (n=57), constables (n=99), senior constables (n=53) and sergeants (n=46)

Probationary Constables (n=57), Constables (n=99), Senior Constables (n=53) vs. Sergeants (n=46)	Independent Variables	Sleepiness Risk (ESS)	Fatigue Severity (FSS)	Total Fatigue Impact (CIS20)
	Years of Age	-		
	TTW	+ / +		
	Lifestyle Risk Factors (LAQ Part 1)			+ / + / + / +
	Perception of Stress (LAQ Part 2)	+ / + / +	+ / + / + / +	+ / + / + / +
	Subjective Sleep Quality (PSQIC1)	+ / + / +	+ / +	+ / + / + / +
	Sleep Onset Latency (PSQIC2)		+ / +	+ / + / +
	Sleep Duration (PSQIC3)	+	+	+ / +
	Sleep Efficiency (PSQIC4)			+
	Sleep Disturbances (PSQIC5)	+	+ / + / + / +	+ / + / +
	Sleep Medication Usage (PSQIC6)		+	+ / +
	Daytime Dysfunction (PSQIC7)	+ / + / + / +	+ / + / + / +	+ / + / + / +
	PSQI Global	+ / + / +	+ / + / + / +	+ / + / + / +

Table 6.48 summarises the significant Pearson's correlations between sleep factors and other variables from the LAQ and PSQI for PC (shown in black) (n=57), C (shown in red) (n=99), SC (shown in green) (n=53) and Sgt (shown in blue) (n=46).

Key: C = Constable, CIS20 = Checklist of Individual Strength, ESS = Epworth Sleepiness Scale, FSS = Fatigue Severity Scale, LAQ = Lifestyle Appraisal Questionnaire, PC = Probationary Constable, PSQIC = Pittsburgh Sleep Quality Index Component, SC = Senior Constable, Sgt = Sergeant, TTW = Total Travel Work Time; + = Positive correlation; - = Negative correlation

Chapter 7 Limitations, Conclusions and Future Directions

The current study identified novel relationships and changes in police officers' blood pressure (BP), stress and sleep health attributable to shift work, as well as explored differences based on their sex, shift and occupational rank. However, several limitations and recommendations must be addressed by future research to ensure continued improvement in the occupational health and safety of shift workers.

7.1 Limitations

The cross-sectional nature of this study limits the scope of its implications to some degree; as physiological data is a highly dynamic measure of the cardiovascular and autonomic nervous systems. Although steps were taken to reduce the variability in the data (i.e., repetition of readings to determine mean values, assessing in the real work environment, etc.) (Eguchi et al., 2009), this study presents a finite glimpse into subjects' physical and mental health at time of testing. Fortunately, this can be addressed by approaching future research with a longitudinal study design, incorporating tools such as a 24-hour ambulatory BP monitor, thereby providing additional physiological measures on the impact of shift work (expanded upon in Section 7.2).

Similar concerns may also be raised with respect to the self-reported nature of the questionnaire battery. Often accused of inherent bias (Choi & Pak, 2005; Rosenman et al., 2011), subjective assessments of stress and sleep health have their shortcomings, however the tools utilised as part of this study have been proven to be reliable and valid (see Section 3.4.2), as well as appropriate based on a number of factors (Kelley et al., 2003). Firstly, majority of the questionnaires used in this study employ repetitive questioning to determine subjects' honesty and diminish potential bias (Buysse et al., 1989; Craig et al., 1996), although this is also ameliorated by the voluntary nature of the project. Secondly, despite the cross-sectional design of the study, most of the responses requested were advised to have been within the last fortnight to three months. Most significantly, the reliability and validity of the questionnaires has been assessed many times in available literature (Neu et al., 2007; Shahid et al., 2010; Gawron, 2016), evidenced by their strong Cronbach alpha values and disease concurrence (detailed in Section 3.5.2).

Although a great number of significant associations and differences were identified between the police officers based on their sex, shift and occupational rank, this study did not take into account specifically which tasks they completed during their regular shift. The nature of police work is highly variable (Orr et al., 2016), ranging from sedentary desk duty to highly demanding and potentially dangerous interactions with violent criminals. Further, information such as whether it was the subjects' first or second day/night shift and if they were partaking in secondary or tertiary employment was not recorded, however the latter is estimated to be only 7-17% within the NSW Police Force (Achterstraat, 2007). Due to the unpredictability of the occupation, and the evidence that different routine police tasks can influence physiological measures (Decker et al., 2016), future studies must determine to what degree these factors may influence the results.

Finally, a conceptual limitation of the present study may be the risk for 'survival bias' (Gershon et al., 2009). This idea refers to those police officers not assessed, either by virtue of the selection criteria or attrition attributable to shift work, who may not accurately have been reflected in the sample. This underrepresentation of affected individuals may have diminished the exact magnitude of the detrimental effects of shift work identified, and could at least in part be reduced by allowing more lenient selection criteria (detailed in Section 3.3) in future studies.

7.2 Conclusions & Future Directions

Police officers serve a vital role in our modern world, maintaining peace and protecting the general public at all hours. Despite the increased prevalence of cardiovascular, stress and sleep disorders associated with its practice (Åkerstedt & Wright, 2009; Pan et al., 2011; Jermendy et al., 2012; Zimberg et al., 2012; Hamta et al., 2017), shift work remains the leading system under which the police operate. Considering the inherent risks of the occupation, evidenced by the greater risk for injury and highest workers compensation claims in Australia (Violanti et al., 2012; Safe Work Australia, 2013), police officers' occupational safety may be further compounded by shift work's propensity for circadian rhythm dysfunction (Shen et al., 2006; Gamble et al., 2011). However, there remains contention in the literature whether shift work has a direct effect upon BP regulation (Suwazono et al., 2008; Hublin et al., 2010; Sfreddo et al., 2010; Ohlander et al., 2015). Hence this study sought to identify relationships between shift work and the cardiovascular, stress and sleep health of general duties police officers, as well as comparing within subgroups based on sex, shift and occupational rank.

Through collaboration with the New South Wales (NSW) Police Force and Police Association of NSW, this study found a significant increase in police officers' systolic BP after shift work. This change was also observed in female officers, those working a day shift and senior constables, and was also reflected in the great number of significant associations of other variables with their BP. Even after accounting for the covariates of age, sex, waist-hip ratio and lifestyle risk factors (Craig et al., 1996), shift work appeared to have an impact on BP regulation most likely due to circadian misalignment, however it was also likely influenced by the physically demanding nature of the policing occupation. Fortunately, the majority of officers assessed were found to experience perceptions of stress within normal bounds, and this was likely attributable to the greater prevalence of desirable coping style prevalence within the cohort. By comparison, despite the preferable rapidly rotating, clockwise orientation structure to their roster system (Knauth, 1993; Lauer, 1995; Achterstraat, 2007), poor sleep quality and severe fatigue was found to predominate within the sample, almost irrespective of sex, shift or occupational rank.

Future studies would benefit from a longitudinal study design and the incorporation of more physiological measures of police officers' cardiovascular, stress and sleep health. A 24-hour holter monitor would allow the visualisation of the cardiac response to real-time police tasks, thereby potentially identifying biomarkers for stress and prediction of fatigue risk (Patel et al., 2011; Vicente et al., 2016). Actigraphy could also be employed to assess overall activity levels during the day, as well as sleep patterns at night (Park et al., 2000; Saksvik et al., 2011a). Another cost effective and minimally invasive procedure would be the sampling of salivary melatonin and cortisol (Kirschbaum & Hellhammer, 1994; Backhaus et al., 2004; Garde & Hansen, 2005; Burgess & Fogg, 2008; Inslicht et al., 2011), thereby allowing further insight into the potential circadian rhythm dysfunction observed with respect to shift work.

Based on the findings of this study, further insight has been made into the detrimental effects shift work may have upon the cardiovascular and sleep health of members of the NSW Police Force. These results highlight the need for educational strategies, ergonomic roster designs and novel interventions that seek to improve general duties police officers' physical and mental health. This could ameliorate the predominating fatigue and health concerns identified by the present study, leading to diminished social and economic burden on society, while most importantly ensuring the occupational safety and general wellbeing of police officers who continue to operate within a shift work system.

Chapter 8 Appendices

8.1 Consent Form

CONSENT FORM

UNIVERSITY OF TECHNOLOGY, SYDNEY
CONSENT FORM

I ____________________ agree to participate in the research project ***'Investigating fatigue and physiological (blood pressure) associations in shift worker police officers'*** (under the original ethics approval: Improving Train Driver Vigilance System (HREC REF NO. 2006-176A) being conducted by ....of the University of Technology, Sydney (UTS) for................................. Funding for this research has been provided by Australian Research Council (ARC) and/or School of Medical and Molecular Biosciences (UTS).

I understand that the purpose of this study is to understand if there are any associations of human physiology to brain function- as this has implications for development of any physiology based devices and/or management programs in the future.

I understand that my participation in this research will involve baseline measures (quite sitting and/or math and word intervention). I understand I will complete questionnaires on lifestyle and brain (cognitive) function. I also understand that measurements such as blood pressure will be collected. I understand there will be minimal risk and/or inconvenience.

I also understand the study will involve screening for blood pressure and the possibility that I may be found to have high blood pressure. If blood pressure is greater than 140/90 mmHg I will be advised to consult a doctor. If blood pressure is greater than 160/100 mmHg (moderate hypertension) prior to the commencement of the study I will not be included in the study and will be advised to consult my doctor. If blood pressure measured anytime during the study greater than 160/100 mmHg the study will be stopped and I will be advised to consult a doctor.

I am aware that I can contact ....on...or the supervisor Associate Professor Sara Lal ((02) 9514-1592 or Sara.Lal@uts.edu.au) if I have any concerns about the research. I also understand that I am free to withdraw my participation from this research project at any time I wish, without consequences, and without giving a reason.

I agree that ....has answered all my questions fully and clearly.

I agree that the research data gathered from this project may be published in a form that does not identify me in any way, and my identity will be kept confidential throughout the whole project.

____ ____/____/____
Signature (participant)

____ ____/____/____
Signature (researcher or delegate)

NOTE:
This study has been approved by the University of Technology, Sydney Human Research Ethics Committee. If you have any complaints or reservations about any aspect of your participation in this research which you cannot resolve with the researcher, you may contact the Ethics Committee through the Research Ethics Officer (ph: 02 9514 9615, Research.Ethics@uts.edu.au) and quote the UTS HREC reference number. Any complaint you make will be treated in confidence and investigated fully and you will be informed of the outcome.

8.2 Introductory Questionnaire

UTS

Introductory Questionnaire

Please answer questions 1 through 8 before signing consent form.

1. What is your Badge Number, Division and Position/Rank?

....

Badge Number/ID Division Position/Rank

2. Number of years in Police service?

....

3. Highest educational attainment?

Less than high school degree	
High school degree	
Associate degree	
Bachelor degree	
Master degree	
Other: Specify	

4. How often a week do you work a 12 hour roster? Specify if more than 2 consecutive.

....

5. How frequently do you smoke?

Non-smoker	
Only socially (once a week)	
Once or twice a day	
Up to 10 a day	
More than 10 a day	

6. How frequently do you drink alcohol?

Non-drinker, or up to 2 a day	
3 - 4 drinks a day	
5 - 8 drinks a day	
9 - 15 drinks a day	
More than 16 drinks a day	

7. Do you take any drugs or medication other than tea, coffee, alcohol and nicotine (eg. sleeping tablets, anti-anxiety drugs such as valium, anti-depressants, hallucinogens, barbiturates, pain-killers, etc?)

No	
Only once or twice a year	
Once or twice a month	
Once or twice a week	
Every day	

8. Do you currently have, or any family history, of a chronic illness (eg. heart disease, cancer, high blood pressure, etc?)

No	
Yes	

Thankyou,

Jaymen Elliott

Neuroscience Research Unit, Medical and Molecular Bioscience Department,

University of Technology, Sydney (UTS)

Chapter 9 References

Achterstraat, P. (2007) *Police Rostering: NSW Police Force*, Audit Office of New South Wales, Sydney, Australia.

Acquadro-Maran, D., Varetto, A., Zedda, M. & Franscini, M. (2014) Stress among Italian male and female patrol police officers: a quali-quantitative study, *Policing: An International Journal of Police Strategies & Management*, **37** (4), pp. 875-890.

Acquadro-Maran, D., Varetto, A., Zedda, M. & Ieraci, V. (2015) Occupational stress, anxiety and coping strategies in police officers, *Occupational Medicine*, **65** (6), pp. 466-473.

Adole, O., Armiyau, A.Y., Edet, B., Audu, M. & Obembe, A. (2015) Coping strategies of Nigerian military service personnel: a survey of an army cantonment in Northern Nigeria, *Nigerian Journal of Psychiatry*, **13** (2).

Åhsberg, E., Kecklund, G., Åkerstedt, T. & Gamberale, F. (2000) Shiftwork and different dimensions of fatigue, *International Journal of Industrial Ergonomics*, **26**, pp. 457-465.

Åkerstedt, T. (2003) Shift work and disturbed sleep/wakefulness, *Occupational Medicine*, **53**, pp. 89-94.

Åkerstedt, T. (2006) Chapter 13 - Stress, Sleep and Restitution, in Arentz, B.B. & Ekman, R., *Stress in Health and Disease*, Wiley, Weinheim, Germany, pp. 243-250.

Åkerstedt, T., Knutsson, A., Alfredsson, L. & Theorell, T. (1984) Shift work and cardiovascular disease, *Scandinavian Journal of Work, Environment & Health*, **10**, pp. 409-414.

Åkerstedt, T., Knutsson, A., Westerholm, P., Theorell, T., Alfredsson, L. & Kecklund, G. (2002) Work organisation and unintentional sleep: results from the WOLF study, *Occupational & Environmental Medicine*, **59** (9), pp. 595-600.

Åkerstedt, T. & Wright, K.P. (2009) Sleep loss and fatigue in shift work and shift work disorder, *Sleep Medicine Clinics*, **4** (2), pp. 257-271.

Akinola, M. & Mendes, W.B. (2012) Stress-induced cortisol facilitates threat-related decision making among police officers, *Behavioural Neuroscience*, **126** (1), pp. 167-174.

Aldwin, C.M. & Revenson, T.A. (1987) Does coping help? A re-examination of the relation between coping and mental health, *Journal of Personality & Social Psychology*, **53**, pp. 337-348.

Alexander, D.A. & Walker, L.G. (1994) A study of methods used by Scottish police officers to cope with work-induced stress, *Stress Medicine*, **10**, pp. 131-138.

Alexander, D.A. & Wells, A. (1991) Reactions of police officers to body-handling after a major disaster: a before-and-after comparison, *British Journal of Psychiatry*, **159**, pp. 547-555.

Alexopoulos, E.C., Palatsidi, V., Tigani, X. & Darviri, C. (2014) Exploring stress levels, job satisfaction, and quality of life in a sample of police officers in Greece, *Safety & Health at Work*, **5** (4), pp. 210-215.

Almondes, K.M. & Araujo, J.F. (2009) The impact of different shift work schedules on the levels of anxiety and stress in workers in a petrochemicals company, *Estudos de Psicologia*, **26** (1), pp. 15-23.

Alvares, G.A., Quintana, D.S., Kemp, A.H., Van Zwieten, A., Balleine, B.W., Hickie, I.B. & Guastella, A.J. (2013) Reduced heart rate variability in social anxiety disorder: associations with gender and symptom severity, *PLoS One*, **8** (7), p. e70468.

Amendola, K.L., Weisburd, D., Hamilton, E.E., Jones, G. & Slipka, M. (2011) An experimental study of compressed work schedules in policing: advantages and disadvantages of various shift lengths, *Journal of Experimental Criminology*, **7**, pp. 407-442.

Anderson, G.S., Litzenberger, R. & Plecas, D. (2002) Physical evidence of police stress, *Policing: An International Journal of Police Strategies & Management*, **25**, pp. 339-420.

Andlauer, P., Reinberg, A., Fourre, L., Battle, W. & Duverneuil, G. (1979) Amplitude of the oral temperature circadian rhythm and the tolerance to shift-work, *Journal de Physique*, **75** (5), pp. 507-512.

Anjum, B., Verma, N.S., Tiwari, S., Mahdi, A.A., Singh, R., Naaz, Q., Mishra, S., Singh, P., Gautam, S. & Bhardwaj, S. (2015) 24 hours chronomics of ambulatory blood pressure and its relation with circadian rhythm of 6-sulfatoxy melatonin in night shift health care workers, *International Journal of Research in Medical Sciences*, **3** (8), pp. 1922-1931.

Anjum, B., Verma, N.S., Tiwari, S., Singh, R., Mahdi, A.A., Singh, R.B. & Singh, R.K. (2011) Association of salivary cortisol with chronomics of 24 hours ambulatory blood pressure/heart rate among night shift workers, *Bioscience Trends*, **5** (4), pp. 182-188.

Anshel, M.H. (2000) A conceptual model and implication for coping with stressful events, *Criminal Justice & Behaviour*, **27** (3), pp. 375-400.

Anshel, M.H., Robertson, M. & Caputi, P. (1997) Sources of acute stress and their appraisals and reappraisals among Australian police as a function of previous experience, *Journal of Occupational & Organizational Psychology*, **70**, pp. 337-356.

Anson, R.H. & Bloom, M.E. (1988) Police stress in an occupational context, *Journal of Police Service & Administration*, **16**, pp. 229-235.

Antoniou, A.S. (2009) Occupation-specific precursors of stress among Greek police officers: the roles of rank and gender, *International Journal of Police Science & Management Volume*, **11** (3), pp. 334-344.

Antunes, L.C., Levandovski, R., Dantas, G., Caumo, W. & Hidalgo, M.P. (2010) Obesity and shift work: chronobiological aspects, *Nutrition Research Reviews*, **23** (1), pp. 155-168.

Arendt, J. (1998) Melatonin and the pineal gland: influence on mammalian seasonal and circadian physiology, *Reviews of Reproduction*, **3** (1), pp. 13-22.

Arendt, J. (2010) Shift work: coping with the biological clock, *Occupational Medicine*, **60**, pp. 10-20.

Arnsten, A.F. (1998) The biology of being frazzled, *Science*, **280**, pp. 1711-1712.

Asare-Anane, H., Abdul-Latif, A., Ofori, E.K., Abdul-Rahman, M. & Amanquah, S.D. (2015) Shift work and the risk of cardiovascular disease among workers in cocoa processing company, Tema, *BMC Research Notes*, **8**, p. 798.

At'kov, O.Y. (2012) Blood pressure in night shift workers: circadian rhythms and levels, and their seasonal variation, *Human Physiology*, **38** (1), pp. 73-6.

Attarchi, M., Dehghan, F., Safakhah, F., Nojomi, M. & Mohammadi, S. (2012) Effect of exposure to occupational noise and shift working on blood pressure in rubber manufacturing company workers, *Industrial Health*, **50** (3), pp. 205-213.

Australian Bureau of Statistics (2006) *National Health Survey: Summary of Results 2004-2005*, http://www.abs.gov.au, Accessed on 02/03/17.

Australian Bureau of Statistics (2013) *4364.0.55.003 – National Health Survey: Updated Results 2011-2012*, http://abs.gov.au, Accessed on 08/09/2013.

Australian Government (2010) *Intergenerational Report 2010: Australia to 2050 - Future Challenges*, CanPrint Communications Pty Ltd, Canberra, Australia.

Australian Safety & Compensation Council (2009) *The Costs of Work-Related Injury and Illness for Australian Employers, Workers and the Community: 2005-06*, Australian Government, Canberra, Australia.

Axelrod, J. & Reisine, T. (1984) Stress hormones: their interactions and regulation, *Science*, **224**, pp. 452-459.

Axelsson, J., Akerstedt, T., Kecklund, G. & Lowden, A. (2004) Tolerance to shift work-how does it relate to sleep and wakefulness?, *International Archives of Occupational & Environmental Health*, **77** (2), pp. 121-129.

Axelsson, J., Kecklund, G., Akerstedt, T. & Lowden, A. (1998) Effects of alternating 8- and 12-hour shifts on sleep, sleepiness, physical effort and performance, *Scandinavian Journal of Work, Environment & Health*, **24** (3), pp. 62-68.

Ayada, C., Ü, T. & Korkut, Y. (2015) The relationship of stress and blood pressure effectors, *Hippokratia*, **19** (2), pp. 99-108.

Backhaus, J., Junghanns, K. & Hohagen, F. (2004) Sleep disturbances are correlated with decreased morning awakening salivary cortisol, *Psychoneuroendocrinology*, **29** (9), pp. 1184-1191.

Badia, P., Myers, B., Boecker, M., Culpepper, J. & Harsh, J.R. (1991) Bright light effects on body temperature, alertness, EEG and behavior, *Physiology & Behavior*, **50** (3), pp. 583-588.

Baker, F.C. & Driver, H.S. (2007) Circadian rhythms, sleep, and the menstrual cycle, *Sleep Medicine*, **8** (6), pp. 613-622.

Balmer, G.M., Pooley, J.A. & Cohen, L. (2014) Psychological resilience of Western Australian police officers: relationship between resilience, coping style, psychological functioning and demographics, *Police Practice & Research*, **15** (4), pp. 270-282.

Band, S.R. & Manuele, C.A. (1987) Stress and police officer performance: an examination of effective coping behaviour, *Journal of Police & Criminal Psychology*, **3**, pp. 30-42.

Bano, B. & Talib, P. (2014) Sex & rank differences in Indian police: an empirical analysis, *The Indian Journal of Industrial Relations*, **49** (4), pp. 618-634.

Barron, S. (2010) Police officer suicide within the New South Wales Police Force from 1999 to 2008, *Police Practice & Research*, **11**, pp. 371-382.

Barton, J., Costa, G., Smith, L., Spelten, E., Totterdell, P. & Folkard, S. (1995) The Standard Shiftwork Index: A battery of questionnaires for assessing shiftwork-related problems, *Work & Stress*, **9**, pp. 3-30.

Barton, J. & Folkard, S. (1993) Advancing versus delaying shift systems, *Ergonomics*, **36** (1-3), pp. 59-64.

Barton, J., Folkard, S., Smith, L. & Poole, C.J. (1994) Effects on health of a change from a delaying to an advancing shift system, *Occupational & Environmental Medicine*, **51**, pp. 749-755.

Baumgart, P. (1991) Circadian rhythm of blood pressure: internal and external time triggers, *Chronobiology International*, **8** (6), pp. 444-450.

Baumgart, P., Walger, P., Fuchs, G., v Eiff, M. & Rahn, K.H. (1989) Diurnal variations of blood pressure in shift workers during day and night shifts, *International Archives of Occupational & Environmental Health*, **61** (7), pp. 463-466.

Bear, M.F., Connors, B.W. & Paradiso, M.A. (2007) *Neuroscience - Exploring The Brain*, Lippincott Williams & Wilkins, Maryland, USA.

Beehr, T.A., Johnson, L.B. & Nieva, R. (1995) Occupational stress: coping of police and their spouses, *Journal of Organizational Behaviour*, **16**, pp. 3-25.

Begg, S., Vos, T., Barker, B., Stevenson, C., Stanley, L. & Lopez, A.D. (2007) *The bruden of disease and injury in Australia 2003*, Australian Institute of Health & Welfare, Canberra, Australia.

Bendak, S. (2003) 12-h workdays: Current knowledge and future directions, *Work & Stress*, 1**7**, pp. 321-336.

Bezerra, C.M., Minayo, M.C. & Constantino, P. (2013) Occupational stress among female police officers, *Ciência & Saúde Coletiva*, **18** (3), pp. 657-666.

Biggam, F., Power, K. & Macdonald, R. (1997a) Coping with the occupational stressors of police work: a study of scottish officers, *Stress Medicine*, **13**, pp. 109-115.

Biggam, F.H., Power, K.G., Macdonald, R.R., Carcary, W.B. & Moodie, E. (1997b) Self-perceived occupational stress and distress in a Scottish police force, *Work & Stress*, **11** (2), pp. 118-133.

Bishop, G.D., Diong, S.M., Enkelmann, H.C. & Why, Y.P. (2001) The relationship between coping and personality among police officers in Singapore, *Journal of Research in Personality*, **35**, pp. 353-374.

Bliwise, D.L. (1999) Sleep and circadian rhythm disorders in aging and dementia, in Turek, F.W. & Zee, P.C., *Regulation of Sleep & Circadian Rhythms*, Dekker, New York, USA, pp. 487-525.

Bøggild, H. & Knutsson, A. (1999) Shift work, risk factors and cardiovascular disease, *Scandinavian Journal of Work, Environment & Health*, **25** (2), pp. 85-99.

Bohle, P. (1997) Does 'hardiness' predict adaptation to shiftwork?, *Work & Stress*, **11**, pp. 369-376.

Boivin, D.B. & Boudreau, P. (2014) Impacts of shift work on sleep and circadian rhythms, *Pathologie Biologie*, **62**, pp. 292-301.

Boivin, D.B. & James, F.O. (2002) Circadian adaptation to night-shift work by judicious light and darkness exposure, *Journal of Biological Rhythms*, **17** (6), pp. 556-567.

Bonnar, A.J. (2000) Stress at work: the beliefs and experiences of police superintendents, *International Journal of Police Science & Management Volume*, **2** (4), pp. 285-302.

Bonneau, J. & Brown, J. (1995) Physical ability, fitness and police work, *Journal of Clinical Forensic Medicine*, **2**, pp. 157-164.

Bonnet, M.H. & Arand, D.L. (1994) The use of prophylactic naps and caffeine to maintain performance during a continuous operation, *Ergonomics*, **37** (6), pp. 1009-1020.

Bonzini, M., Palmer, K.T., Coggon, D., Carugno, M., Cromi, A. & Ferrario, M.M. (2011) Shift work and pregnancy outcomes: a systematic review with meta-analysis of currently available epidemiological studies, *BJOG: An International Journal of Obstetrics & Gynaecology*, **118** (12), pp. 1429-1437.

Bourdouxhe, M., Queinnec, Y., Granger, D., Baril, R.H., Guertin, S., Massicotte, P., Levy, M. & Lemay, F. (1999) Aging and shiftwork: the effects of 20 years of rotating 12-hour shifts among petroleum refinery operators, *Experimental Aging Research*, **25**, pp. 323-329.

Broussard, J. & Brady, M.J. (2010) The impact of sleep disturbances on adipocyte function and lipid metabolism, *Best Practice & Research Clinical Endocrinology & Metabolism*, **24** (5), pp. 763-773.

Broussard, J.L. & Van Cauter, E. (2016) Disturbances of sleep and circadian rhythms: novel risk factors for obesity, *Current Opinion in Endocrinology, Diabetes & Obesity*, **23** (5), pp. 353-359.

Brown, I.D. (1994) Driver fatigue, *Human Factors*, **36** (2), pp. 298-314.

Brown, J., Cooper, C. & Kirkcaldy, B. (1996) Occupational stress among senior police officers, *British Journal of Psychology*, **87**, pp. 31-41.

Brown, J. & Fielding, J. (1993) Qualitative differences in men and women police officers' experience of occupational stress, *Work & Stress*, **7** (4), pp. 327-340.

Brown, J. & Trottier, A. (1995) Assessing cardiac risks in police officers, *Journal of Clinical Forensic Medicine*, **2**,(pp. 199-204.

Brown, J.M. & Campbell, E.A. (1990) Sources of occupational stress in the police, *Work Stress*, **4**, pp. 305-318.

Brown, S.A., Pagani, L., Cajochen, C. & Eckert, A. (2011) Systemic and cellular reflections on ageing and the circadian oscillator: a mini-review, *Gerontology*, **57** (5), pp. 427-434.

Brum, M.C., Filho, F.F., Schnorr, C.C., Bottega, G.B. & Rodrigues, T.C. (2015) Shift work and its association with metabolic disorders, *Diabetology & Metabolic Syndrome*, **7**, p. 45.

Buckley, T.M. & Schatzberg, A.F. (2005) On the interactions of the hypothalamic-pituitary-adrenal (HPA) axis and sleep: normal HPA axis activity and circadian rhythm, exemplary sleep disorders, *The Journal of Clinical Endocrinology & Metabolism*, **90** (5), pp. 3106-3114.

Bültmann, U., de Vries, M., Beurskens, A.J., Bleijenberg, G., Vercoulen, J.H. & Kant, I. (2000) Measurement of prolonged fatigue in the working population: determination of a cutoff point for the checklist individual strength, *Journal of Occupational Health Psychology*, **5** (4), pp. 411-416.

Burgess, H.J. & Fogg, L.F. (2008) Individual differences in the amount and timing of salivary melatonin secretion, *PLoS One*, **3** (8), p. e3055.

Burgueno, A., Gemma, C., Gianotti, T.F., Sookoian, S. & Pirola, C.J. (2010) Increased levels of resistin in rotating shift workers: a potential mediator of cardiovascular risk associated with circadian misalignment, *Atherosclerosis*, **210** (2), pp. 625-629.

Bursey, R.G. (1990) A cardiovascular study of shift workers with respect to coronary artery disease risk factor prevalence, *The Journal of the Society of Occupational Medicine*, **40** (2), pp. 65-67.

Burstyn, P., O'Donovan, B. & Charlton, I. (1981) Blood pressure variability: the effects of repeated measurement, *Postgraduate Medical Journal*, **57** (670), pp. 488-491.

Buxton, O.M., Cain, S.W., O'Connor, S.P., Porter, J.H., Duffy, J.F., Wang, W., Czeisler, C.A. & Shea, S.A. (2012) Adverse metabolic consequences in humans of prolonged sleep restriction combined with circadian disruption, *Science Translational Medicine*, **4** (129), p. 129ra43.

Buysse, D.J., Reynolds, C.F., 3rd, Monk, T.H., Berman, S.R. & Kupfer, D.J. (1989) The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research, *Psychiatry Research*, **28** (2), pp. 193-213.

Campolo, M., Pugh, J., Thompson, L. & Wallace, M. (1998) Pioneering the 12-hour shift in Australia--implementation and limitations, *Australian Critical Care*, **11** (4), pp. 112-115.

Cannon, W.B. (1932) *The Wisdom of the Body*, W.W. Norton, New York, USA.

Carev, M., Karanovic, N., Bagatin, J., Matulic, N.B., Pecotic, R., Valic, M., Marinovic-Terzic, I., Karanovic, S. & Dogas, Z. (2011) Blood pressure dipping and salivary cortisol as markers of fatigue and sleep deprivation in staff anesthesiologists, *Collegium Antropologicum*, **35** (1), pp. 133-138.

Carlier, I.V., Lamberts, R. & Gersons, B.P. (1997) Risk factors for posttraumattic stress symptomatology in police officers: a prospective analysis, *The Journal of Nervous & Mental Disease*, **185**, pp. 498-506.

Carpenter, J.S. & Andrykowski, M.A. (1998) Psychometric evaluation of the Pittsburgh Sleep Quality Index, *Journal of Psychosomatic Research*, **45** (1), pp. 5-13.

Carrington, M.J., Jennings, G.L. & Stewart, S. (2010) Pattern of blood pressure in Australian adults: results from a national blood pressure screening day of 13,825 adults, *International Journal of Cardiology*, **145** (3), pp. 461-467.

Chang, J.H., Huang, P.T., Lin, Y.K., Lin, C.E., Lin, C.M., Shieh, Y.H. & Lin, Y.C. (2015) Association between sleep duration and sleep quality, and metabolic syndrome in Taiwanese police officers, *International Journal of Occupational Medicine & Environmental Health*, **28** (6), pp. 1011-1023.

Charles, L.E., Slaven, J.E., Mnatsakanova, A., Ma, C., Violanti, J.M., Fekedulegn, D., Andrew, M.E., Vila, B.J. & Burchfiel, C.M. (2011) Association of perceived stress with sleep duration and sleep quality in police officers, *International Journal of Emergency Mental Health*, **13** (4), pp. 229-241.

Chobanian, A., Bakris, G., Black, H., Cushman, W., Green, L., Izzo, J., Jr., Jones, D., Materson, B., Oparil, S., Wright, J., Jr. & Roccella, E. (2003) Seventh report of the joint national committee on prevention, detection, evaluation and treatment of high blood pressure, *Hypertension*, **42**, pp. 1206-1252.

Choi, B.C. & Pak, A.W. (2005) A catalog of biases in questionnaires, *Preventing Chronic Disease*, **2** (1), p. A13.

Choi, B.K., Schnall, P. & Dobson, M. (2016) Twenty-four hour work shifts, increased job demands and elevated blood pressure in professional firefighters, *International Archives of Occupational & Environmental Health*, **89** (7), pp. 1111-1125.

Cohen, J. (1988) *Statistical Power Analysis for the Behavioural Sciences*, Erlbaum, Hillsdale, USA.

Collins, P.A. & Gibbs, A.C. (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), pp. 256-264.

Conlon, M., Lightfoot, N. & Kreiger, N. (2007) Rotating shift work and risk of prostate cancer, *Epidemiology*, **18**, (1), pp. 182-183.

Cooper, C.L., Davidson, M.J. & P., R. (1982) Stress in the police service, *Journal of Occupational Medicine*, **24**, pp. 30-36.

Costa, G. (2003) Shift work and occupational medicine: an overview, *Occupational Medicine*, **53** (2), pp. 83-88.

Costa, G. (2015) Sleep deprivation due to shift work, *Handbook of Clinical Neurology*, **131**, pp. 437-446.

Costa, G. & Di Milia, L. (2008) Aging and shift work: a complex problem to face, *Chronobiology International*, **25**, pp. 165-181.

Cox, T. (1978) *Stress*, MacMillan, London, UK.

Craig, A., Hancock, K. & Craig, M. (1996) The lifestyle appraisal questionnaire: A comprehensive assessment of health and stress, *Psychology & Health*, **11** (3), pp. 331-343.

Czeisler, C.A., Allan, J.S., Strogatz, S.H., Ronda, J.M., Sanchez, R., Rios, C.D., Freitag, W.O., Richardson, G.S. & Kronauer, R.E. (1986) Bright light resets the human circadian pacemaker independent of the timing of the sleep-wake cycle, *Science*, **233** (4764), pp. 667-671.

Czeisler, C.A., Moore-Ede, M.C. & Coleman, R.M. (1982) Rotating shift work schedules that disrupt sleep are improved by applying circadian principles, *Science*, **217**, pp. 460-463.

Dallman, M.F. (1993) Stress update Adaptation of the hypothalamic-pituitary-adrenal axis to chronic stress, *Trends in Endocrinology & Metabolism*, **4** (2), pp. 62-69.

Dantzer, M.L. (1987) Police related stress: a critique for future research, *Journal of Police & Criminal Psychology*, **3**, pp. 43-48.

Davidson, M.J. & Veno, A. (1980) Stress and the policeman, in C.L. Cooper & J.R. Marshall (eds), *White Collar & Professional Stress*, Wiley, Chichester, England.

Davy, J. & Gobel, M. (2013) The effects of a self-selected nap opportunity on the psychophysiological, performance and subjective measures during a simulated industrial night shift regimen, *Ergonomics*, **56** (2), pp. 220-234.

de Koning, L., Merchant, A.T., Pogue, J. & Anand, S.S. (2007) Waist circumference and waist-to-hip ratio as predictors of cardiovascular events: meta-regression analysis of prospective studies, *European Heart Journal*, **28** (7), pp. 850-856.

Deacon, S. & Arendt, J. (1996) Adapting to phase shifts, I. An experimental model for jet lag and shift work, *Physiology & Behavior*, **59** (4-5), pp. 665-673.

Decker, A., Orr, R., Pope, R. & Hinton, B. (2016) *Physiological demands of law enforcement occupational tasks in Australian police*, Bond University, http://epublications.bond.edu.au/tru_conf/22, Accessed on 04/02/2017.

Deschamps, F., Paganon-Badinier, I., Marchand, A.C. & Merle, C. (2003) Sources and assessment of occupational stress in the police, *Journal of Occupational Health*, **45** (6), pp. 358-364.

Di Lorenzo, L., De Pergola, G., Zocchetti, C., L'Abbate, N., Basso, A., Pannacciulli, N., Cignarelli, M., Giorgino, R. & Soleo, L. (2003) Effect of shift work on body mass index: results of a study performed in 319 glucose-tolerant men working in a Southern Italian industry, *International Journal of Obesity & Related Metabolic Disorders*, **27** (11), pp. 1353-1358.

Dinges, D.F. (1995) An overview of sleepiness and accidents, *Journal of Sleep Research*, **4**, pp. 4-14.

Dinges, D.F., Whitehouse, W.G., Orne, E.C. & Orne, M.T. (1988) The benefits of a nap during prolonged work and wakefulness, *Work & Stress*, **2**, pp. 139-153.

Dominguez-Rodriguez, A., Abreu-Gonzalez, P. & Kaski, J. (2009) Disruption of normal circadian rhythms and cardiovascular events, *Heart & Metabolism*, **44**,(pp. 11-15.

Dowler, K. & Arai, B. (2008) Stress, gender and policing: the impact of perceived gender discrimination on symptoms of stress, *International Journal of Police Science & Management Volume*, **10** (2), pp. 123-135.

Drake, C.L., Roehrs, T., Richardson, G., Walsh, J.K. & Roth, T. (2004) Shift work sleep disorder: prevalence and consequences beyond that of symptomatic day workers, *Sleep*, **27** (8), pp. 1453-1462.

Driscoll, T.R., Grunstein, R.R. & Rogers, N.L. (2007) A systematic review of the neurobehavioural and physiological effects of shiftwork systems, *Sleep Medicine Reviews*, **11** (3), pp. 179-194.

Duez, H. & Staels, B. (2010) Nuclear receptors linking circadian rhythms and cardiometabolic control, *Arteriosclerosis, Thrombosis & Vascular Biology*, **30**, (8), pp. 1529-1534.

Eastman, C.I. (1990) Circadian rhythms and bright light: Recommendations for shift work, *Work & Stress*, **4**, pp. 245-260.

Eek, F., Karlson, B., Garde, A.H., Hansen, A.M. & Orbaek, P. (2012) Cortisol, sleep, and recovery - Some gender differences but no straight associations, *Psychoneuroendocrinology*, **37** (1), pp. 56-64.

Eguchi, K., Kuruvilla, S., Ogedegbe, G., Gerin, W., Schwartz, J.E. & Pickering, T.G. (2009) What is the optimal interval between successive home blood pressure readings using an automated oscillometric device?, *Journal of Hypertension*, **27** (6), pp. 1172-1177.

Eldevik, M.F., Flo, E., Moen, B.E., Pallesen, S. & Bjorvatn, B. (2013) Insomnia, excessive sleepiness, excessive fatigue, anxiety, depression and shift work disorder in nurses having less than 11 hours in-between shifts, *PLoS One*, **8** (8), p. e70882.

Elliott, J.L. & Lal, S. (2016) Blood Pressure, Sleep Quality and Fatigue in Shift Working Police Officers: Effects of a Twelve Hour Roster System on Cardiovascular and Sleep Health, *International Journal of Environmental Research & Public Health*, **13** (2), p. 172.

EPG Health Media Ltd (2012) *Understanding Sleep - Melatonin*, http://www.epg.online.org, Accessed on 03/09/2013.

Erblich, J., Bovbjerg, D.H. & Sloan, R.P. (2011) Exposure to smoking cues: cardiovascular and autonomic effects, *Addictive Behaviours*, **36** (7), pp. 737-742.

Eriksen, C.A. & Kecklund, G. (2007) Sleep, sleepiness and health complaints in police officers: the effects of a flexible shift system, *Industrial Health*, **45**, pp. 279-288.

Esquirol, Y., Perret, B., Ruidavets, J.B., Marquie, J.C., Dienne, E., Niezborala, M. & Ferrieres, J. (2011) Shift work and cardiovascular risk factors: new knowledge from the past decade, *Archives of Cardiovascular Diseases*, **104** (12), pp. 636-668.

Evans, B., Coman, G., Stanley, R. & Burrows, G. (1993) Police officers' coping strategies: an Australian police survey, *Stress Medicine*, **9**, pp. 237-246.

Everitt, B. & Palmer, C. (2011) *Encyclopaedic Companion to Medical Statistics: Second Edition*, John Wiley & Sons Ltd, West Sussex, UK.

Fekedulegn, D., Burchfiel, C.M., Hartley, T.A., Andrew, M.E., Charles, L.E., Tinney-Zara, C.A. & Violanti, J.M. (2013) Shiftwork and sickness absence among police officers: the BCOPS study, *Chronobiology International*, **30** (7), pp. 930-941.

Fekedulegn, D.B., Burchfiel, C.M., Charles, L.E., Hartley, T.A., Andrew, M.E. & Violanti, J.M. (2014) Shift work and sleep quality among urban police officers, *Annals of Epidemiology*, **24**, pp. 682-702.

Felson, M. & Poulsen, E. (2003) Simple indicators of crime by time of day, *International Journal of Forecasting*, **19**, pp. 595-601.

Ferrara, M. & De Gennaro, L. (2001) How much sleep do we need?, *Sleep Medicine Reviews*, **5** (2), pp. 155-179.

Ferreira, L.R., Miguel, M.A., De Martino, M.M. & Menna-Barreto, L. (2012) Circadian rhythm of wrist temperature and night shift-work, *Biological Rhythm Research*, **1**, pp. 1-8.

Ferri, P., Guadi, M., Marcheselli, L., Balduzzi, S., Magnani, D. & Di Lorenzo, R. (2016) The impact of shift work on the psychological and physical health of nurses in a general hospital: a comparison between rotating night shifts and day shifts, *Risk Manag Healthc Policy*, **9**, pp. 203-211.

Ficca, G., Axelsson, J., Mollicone, D.J., Muto, V. & Vitiello, M.V. (2010) Naps, cognition and performance, *Sleep Medicine Reviews*, **14** (4), pp. 249-258.

Finn, P. (1997) Reducing stress: an organization-centered approach, *FBI Law Enforcement Bulletin*, **66**, pp. 20-26.

Flynn, M.A., Nolph, G.B., Baker, A.S. & Krause, G. (1992) Aging in humans: a continuous 20-year study of physiologic and dietary parameters, *The Journal of the American College of Nutrition*, **11** (6), pp. 660-672.

Folkard, S., Monk, T.H. & Lobban, M.C. (1979) Towards a predictive test of adjustment to shift work, *Ergonomics*, **22** (1), pp. 79-91.

Folkard, S., Spelten, E., Totterdell, P., Barton, J. & Smith, L. (1995) The use of survey measures to assess circadian variations in alertness, *Sleep*, **18**, pp. 355-361.

Folkman, S. & Lazarus, R.S. (1980) An analysis of coping in a middle-aged community sample, *Journal of Health & Social Behaviour*, **21** (3), pp. 219-239.

Folkman, S., Lazarus, R.S., Dunkel-Schetter, C., DeLongis, A. & Gruen, R.J. (1986) Dynamics of a stressful encounter: cognitive appraisal, coping, and encounter outcomes, *The Journal of Personality & Social Psychology*, **50** (5), pp. 992-1003.

Folkow, B. (1989) Sympathetic nervous control of blood pressure. Role in primary hypertension, *American Journal of Hypertension*, **2** (3), pp. 103S-11S.

Franklin, S.S., Gustin, W.t., Wong, N.D., Larson, M.G., Weber, M.A., Kannel, W.B. & Levy, D. (1997) Hemodynamic patterns of age-related changes in blood pressure. The Framingham Heart Study, *Circulation*, **96** (1), pp. 308-315.

Frith, J., Zalewski, P., Klawe, J.J., Pairman, J., Bitner, A., Tafil-Klawe, M. & Newton, J.L. (2012) Impaired blood pressure variability in chronic fatigue syndrome--a potential biomarker, *QJM: An International Journal of Medicine*, **105** (9), pp. 831-838.

Gamble, K.L., Motsinger-Reif, A.A., Hida, A., Borsetti, H.M., Servick, S.V., Ciarleglio, C.M., Robbins, S., Hicks, J., Carver, K., Hamilton, N., Wells, N., Summar, M.L., McMahon, D.G. & Johnson, C.H. (2011) Shift work in nurses: contribution of phenotypes and genotypes to adaptation, *PLoS One*, **6** (4), p. e18395.

Gangwisch, J.E., Heymsfield, S.B., Boden-Albala, B., Buijs, R.M., Kreier, F., Pickering, T.G., Rundle, A.G., Zammit, G.K. & Malaspina, D. (2006) Short sleep duration as a risk factor for hypertension: analyses of the first National Health and Nutrition Examination Survey, *Hypertension*, **47** (5), pp. 833-839.

Garbarino, S. & Magnavita, N. (2015) Work Stress and Metabolic Syndrome in Police Officers. A Prospective Study, *PLoS One*, **10** (12), p. e0144318.

Garde, A.H. & Hansen, A.M. (2005) Long-term stability of salivary cortisol, *Scandinavian Journal of Clinical & Laboratory Investigation*, **65** (5), pp. 433-436.

Gawron, V.J. (2016) Overview of self-reported measures of fatigue, *The International Journal of Aviation Psychology*, **26** (3-4), pp. 120-131.

Gerber, M., Hartmann, T., Brand, S., Holsboer-Trachsler, E. & Puhse, U. (2010) The relationship between shift work, perceived stress, sleep and health in Swiss police officers, *Journal of Criminal Justice*, **38**, pp. 1167-1175.

Gerber, M., Kellman, M., Hartmann, T. & Puhse, U. (2010) Do exercise and fitness buffer against stress among Swiss police and emergenc response service officers?, *Psychology of Sport & Exercise*, **11**, pp. 286-294.

Gershon, R.R., B., B., Canton, A.N., Li, X. & Vlahov, D. (2009) Mental, physical and behavioural outcomes associated with perceived work stress in police officers, *Criminal Justice & Behaviour*, **36** (3), pp. 275-289.

Gershon, R.R., Lin, S.H. & Li, X. (2002) Work stress in aging police officers, *Journal of Occupational & Environmental Medicine*, **44**, pp. 160-167.

Gholami-Fesharaki, M., Kazemnejad, A., Zayeri, F., Rowzati, M. & Akbari, H. (2014a) Historical cohort study of shift work and blood pressure, *Occupational Medicine*, **64** (2), pp. 109-112.

Gholami-Fesharaki, M., Kazemnejad, A., Zayeri, F., Rowzati, M., Sanati, J. & Akbari, H. (2014b) Multicenter historical cohort study of the relationship between shift work and blood pressure, *ARYA Atherosclerosis*, **10** (6), pp. 287-291.

Gillberg, M., Kecklund, G., Axelsson, J. & Akerstedt, T. (1996) The effects of a short daytime nap after restricted night sleep, *Sleep*, **19** (7), pp. 570-575.

Gordon, N.P., Cleary, P.D., Parker, C.E. & Czeisler, C.A. (1986) The prevalence and health impact of shiftwork, *American Journal of Public Health*, **76** (10), pp. 1225-1228.

Gottfredson, D.C. & Soulé, D.A. (2004) The timing of property crime, violent crime and substance use among juveniles, *Journal of Research in Crime & Delinquency*, **40**, pp. 1-11.

Gultekin, K. (2014) The reform era of policing: how does organizational structure influence organizational culture?, *European Scientific Journal*, **10** (8), pp. 508-518.

Gundjonsson, G.H. & Adlam, K.R. (1985) Occupational stressors among British police officers, *The Police Journal*, **58**, pp. 73-80.

Guo, Y., Liu, Y., Huang, X., Rong, Y., He, M., Wang, Y., Yuan, J., Wu, T. & Chen, W. (2013) The effects of shift work on sleeping quality, hypertension and diabetes in retired workers, *PLoS One*, **8** (8), p. e71107.

Guo, Y., Rong, Y., Huang, X., Lai, H., Luo, X., Zhang, Z., Liu, Y., He, M., Wu, T. & Chen, W. (2015) Shift work and the relationship with metabolic syndrome in Chinese aged workers, *PLoS One*, **10** (3), p. e0120632.

Haarr, R.N. & Morash, M. (1999) Gender, race and strategies of coping with occupational stress in policing, *Justice Quarterly*, **16**, pp. 303-336.

Haarr, R.N. & Morash, M. (2013) The effect of rank on police women coping with discrimination and harassment, *Police Quarterly*, **16** (4), pp. 395-419.

Habib, K.E., Gold, P.W. & Chrousos, G.P. (2001) Neuroendocrinology of stress, *Endocrinology & Metabolism Clinics of North America*, **30** (3), pp. 695-728.

Hamta, A., Kazemnejad, A., Gholami-Fesharaki, M. & Rowzati, M. (2017) Simultaneous effect of shift work on blood pressure and lipid profile: a path analysis, *International Journal of Occupational Safety & Ergonomics*, **24** (1), pp. 1-14.

Härmä, M. (1993) Individual differences in tolerance to shiftwork: A review, *Ergonomics*, **36**, pp. 101-109.

Härmä, M. (1995) Sleepiness and shiftwork: individual differences, *Journal of Sleep Research*, **4**, pp. 57-61.

Härmä, M. (1996) Ageing, physical fitness and shiftwork tolerance, *Applied Ergonomics*, **27**, pp. 25-29.

Härmä, M., Knauth, P., Ilmarinen, J. & Ollila, H. (1990) The relation of age to the adjustment of the circadian rhythms of oral temperature and sleepiness to shift work, *Chronobiology International*, **7**, pp. 227-233.

Harrington, J.M. (2001) Health effects of shift work and extended hours of work, *Occupational & Environmental Medicine*, **58**, pp. 68-72.

Harris, A., Nagy, S. & Vardaxis, N. (2009) *Mosby's Dictionary of Medicine, Nursing & Health Professions - Australian & New Zealand Edition*, Elsevier, Sydney, Australia.

Harris, A., Waage, S., Ursin, H., Hansen, A.M., Bjorvatn, B. & Eriksen, H.R. (2010) Cortisol, reaction time test and health among offshore shift workers, *Psychoneuroendocrinology*, **35** (9), pp. 1339-1347.

Harrison, Y. & Horne, J.A. (2000) The impact of sleep deprivation on decision making: a review, *Journal of Experimental Psychology*, **6** (3), pp. 236-249.

Hartley, T.A., Burchfiel, C.M., Fekedulegn, D., Andrew, M.E. & Violanti, J.M. (2011) Health disparities in police officers: comparisons to the U.S. general population, *International Journal of Emergency Mental Health*, **13** (4), pp. 211-220.

Hassell, K.D., Archbold, C.A. & Stichman, A.J. (2011) Comparing the workplace experiences of male and female police officers: examining workplace problems, stress, job satisfaction and consideration of career change, *International Journal of Police Science & Management Volume*, **13** (1), pp. 37-53.

Haupt, C.M., Alte, D., Dorr, M., Robinson, D.M., Felix, S.B., John, U. & Volzke, H. (2008) The relation of exposure to shift work with atherosclerosis and myocardial infarction in a general population, *Atherosclerosis*, **201** (1), pp. 205-211.

Haus, E.L. & Smolensky, M.H. (2013) Shift work and cancer risk: potential mechanistic roles of circadian disruption, light at night, and sleep deprivation, *Sleep Medicine Reviews*, **17** (4), pp. 273-284.

He, N., Zhao, J. & Ren, L. (2005) Do race and gender matter in police stress? A preliminary assessment of the interactive effects, *Journal of Criminal Justice*, **33**, pp. 535-547.

Heaton, K. & Anderson, D. (2007) A psychometric analysis of the Epworth Sleepiness Scale, *Journal of Nursing Measurement*, **15** (3), pp. 177-188.

Heiman, G. (2010) *Basic Statistics for the Behavioural Sciences: Sixth Edition*, Nelson Education Ltd, Ontario, Canada.

Hemamalini, R.V., Priyadarshini, A. & Saravanan, A. (2013) Effect of shift work on risk factors of cardiovascular diseases, *International Journal of Current Research & Review*, **5** (22), pp. 39-45.

Hennig, J., Kieferdorf, P., Moritz, C., Huwe, S. & Netter, P. (1998) Changes in cortisol secretion during shiftwork: implications for tolerance to shiftwork?, *Ergonomics*, **41** (5), pp. 610-621.

Herman, J.P. & Cullinan, W.E. (1997) Neurocircuitry of stress: central control of the hypothalamic-pituitary-adrenocortical axis, *Trends in Neuroscience*, **20**, pp. 78 - 84.

Hermida, R.C., Ayala, D.E. & Portaluppi, F. (2007) Circadian variation of blood pressure: the basis for the chronotherapy of hypertension, *Advanced Drug Delivery Reviews*, **59** (9-10), pp. 904-922.

Hesselink, J.K., de Leede, J. & Goudswaard, A. (2010) Effects of the new fast forward rotating five-shift roster at a Dutch steel company, *Ergonomics*, **53**, (pp. 727-38.

Hickman, M.J., Fricas, J., Strom, K.J. & Pope, M.W. (2011) Mapping police stress, *Police Quarterly*, **14** (3), pp. 227-250.

Horne, J.A. (1978) A review of the biological effect of total sleep deprivation in man, *Biological Psychology*, **7**, pp. 55-102.

Hossain, J.L., Ahmad, P., Reinish, L.W., Kayumov, L., Hossain, N.K. & Shapiro, C.M. (2005) Subjective fatigue and subjective sleepiness: two independent consequences of sleep disorders?, *Journal of Sleep Research*, **14** (3), pp. 245-253.

Hossain, J.L., Reinish, L.W., Kayumov, L., Bhuiya, P. & Shapiro, C.M. (2003) Underlying sleep pathology may cause chronic high fatigue in shift-workers, *Journal of Sleep Research*, **12** (3), pp. 223-230.

Hublin, C., Partinen, M., Koskenvuo, K., Silventoinen, K., Koskenvuo, M. & Kaprio, J. (2010) Shift-work and cardiovascular disease: a population-based 22-year follow-up study, *European Journal of Epidemiology*, **25** (5), pp. 315-323.

Humm, C. (2008) Night-shift napping, *Nursing Standard*, **22**, (17), pp. 20-21.

Husain, W., Sajjad, R. & Rehman, A.U. (2014) Depression, anxiety and stress among female and male police officers, *Pakistan Journal of Clinical Psychology*, **13** (1), pp. 3-14.

Inslicht, S.S., Otte, C., McCaslin, S.E., Apfel, B.A., Henn-Haase, C., Metzler, T., Yehuda, R., Neylan, T.C. & Marmar, C.R. (2011) Cortisol awakening response prospectively predicts peritraumatic and acute stress reactions in police officers, *Biological Psychiatry*, **70** (11), pp. 1055-1062.

Jankowiak, S., Backe, E., Liebers, F., Schulz, A., Hegewald, J., Garthus-Niegel, S., Nubling, M., Blankenberg, S., Pfeiffer, N., Lackner, K.J., Beutel, M., Blettner, M., Munzel, T., Wild, P.S., Seidler, A., Letzel, S. & Latza, U. (2016) Current and cumulative night shift work and subclinical atherosclerosis: results of the Gutenberg Health Study, *International Archives of Occupational & Environmental Health*, **89** (8), pp. 1169-1182.

Javaheri, S., Storfer-Isser, A., Rosen, C.L. & Redline, S. (2008) Sleep quality and elevated blood pressure in adolescents, *Circulation*, **118** (10), pp. 1034-1040.

Jermendy, G., Nadas, J., Hegyi, I., Vasas, I. & Hidvegi, T. (2012) Assessment of cardiometabolic risk among shift workers in Hungary, *Health & Quality of Life Outcomes*, **10**, p. 18.

Johns, M.W. (1991) A new method for measuring daytime sleepiness: the Epworth sleepiness scale, *Sleep*, **14** (6), pp. 540-545.

Johns, M.W. (1992) Reliability and factor analysis of the Epworth Sleepiness Scale, *Sleep*, **15** (4), pp. 376-381.

Johnson, S., Cooper, C., Cartwright, S., Donald, I., Taylor, P. & Millet, C. (2005) The experience of work-related stress across occupations, *Journal of Managerial Psychology*, **20** (2), pp. 178-187.

Kaiseler, M., Queiros, C., Passos, F. & Sousa, P. (2014) Stress appraisal, coping, and work engagement among police recruits: an exploratory study, *Psychological Reports*, **114** (2), pp. 635-646.

Kajantie, E. & Phillips, D.I. (2006) The effects of sex and hormonal status on the physiological response to acute psychosocial stress, *Psychoneuroendocrinology*, **31**, pp. 151-178.

Kalantary, S., Dehghani, A., Yekaninejad, M.S., Omidi, L. & Rahimzadeh, M. (2015) The effects of occupational noise on blood pressure and heart rate of workers in an automotive parts industry, *ARYA Atherosclerosis*, **11** (4), pp. 215-219.

Kales, S., Tsismenakis, A., Zhang, C. & Soteriades, E. (2009) Blood pressure in firefighters, police officers and other emergency responders, *American Journal of Hypertension*, **22**, pp. 11-20.

Kaliterna, L. & Prizmić, Z. (1998) Evaluation of the Survey of Shiftworkers (SOS) short version of the Standard Shiftwork Index, *International Journal of Industrial Ergonomics*, **21**, pp. 259-265.

Karasek, R.A. (1979) Job demands, job decision latitude and mental strain: implications for job design, *Administrative Science Quarterly*, **24**, pp. 385-408.

Karlson, B., Eek, F., Orbaek, P. & Osterberg, K. (2009) Effects on sleep-related problems and self-reported health after a change of shift schedule, *Journal of Occupational Health Psychology*, **14** (2), pp. 97-109.

Kaur, R., Chodagiri, V.K. & Reddi, N.K. (2013) A psychological study of stress, personality and coping in police personnel, *Indian Journal of Psychological Medicine*, **35** (2), pp. 141-147.

Kawachi, I., Colditz, G.A., Stampfer, M.J., Willett, W.C., Manson, J.E., Speizer, F.E. & Hennekens, C.H. (1995) Prospective study of shift work and risk of coronary heart disease in women, *Circulation*, **92** (11), pp. 3178-3182.

Kazemi, R., Haidarimoghadam, R., Motamedzadeh, M., Golmohamadi, R., Soltanian, A. & Zoghipaydar, M.R. (2016) Effects of shift work on cognitive performance, sleep quality and sleepiness among petrochemical control room operators, *Journal of Circadian Rhythms*, **14**, pp. 1-8.

Keckland, G. & Åkerstedt, T. (1993) Sleepiness in long distance truck driving: an ambulatory EEG study of night driving, *Ergonomics*, **36**, pp. 1007-1017.

Kelley, K., Clark, B., Brown, V. & Sitzia, J. (2003) Good practice in the conduct and reporting of survey research, *The International Journal for Quality in Health Care*, **15** (3), pp. 261-266.

Kim, J.L., Wells, W., Vardalis, J.J., Johnson, S.K. & Lim, H. (2016a) Gender differences in occupational stress: A study of the South Korean police agency, *International Journal of Law, Crime & Justice*, **44**, pp. 163-182.

Kim, J.Y., Chae, C.H., Kim, Y.O., Son, J.S., Kim, J.H., Kim, C.W., Park, H.O., Lee, J.H. & Kwon, S.I. (2015) The relationship between quality of sleep and night shift rotation interval, *Annals of Occupational & Environmental Medicine*, **27**, p. 31.

Kim, S.W., Jang, E.C., Kwon, S.C., Han, W., Kang, M.S., Nam, Y.H. & Lee, Y.J. (2016b) Night shift work and inflammatory markers in male workers aged 20-39 in a display manufacturing company, *Ann Occup Environ Med*, **28**, p. 48.

Kirkcaldy, B., Brown, J. & Cooper, C.L. (1998) The demographics of occupational stress among police superintendents, *Journal of Managerial Psychology*, **13** (1), pp. 90-101.

Kirkcaldy, B., Cooper, C.L. & Ruffalo, P. (1995) Work stress and health in a sample of U.S. police, *Psychological Reports*, **76** (2), pp. 700-702.

Kirschbaum, C. & Hellhammer, D.H. (1994) Salivary cortisol in psychoneuroendocrine research: recent developments and applications, *Psychoneuroendocrinology*, **19** (4), pp. 313-333.

Kirschman, E. (2006) The police officer's paradox, *I Love A Cop: What Police Families Need To Know*, Guildford Press, New York, USA, pp. 28-42.

Knauth, P. (1993) The design of shift systems, *Ergonomics*, **36**, pp. 15-28.

Knauth, P. (1995) Speed and direction of shift rotation, *Journal of Sleep Research*, **4** (S2), pp. 41-46.

Knauth, P. & Hornberger, S. (1998) Changes from weekly backward to quicker forward rotating shift systems in the steel industry, *International Journal of Industrial Ergonomics*, **21**, pp. 267-273.

Knutsson, A., Hallquist, J., Reuterwall, C., Theorell, T. & Akerstedt, T. (1999) Shiftwork and myocardial infarction: a case-control study, *Occupational & Environmental Medicine*, **56** (1), pp. 46-50.

Kobasa, S.C. (1979) Stressful life events, personality and health: an enquiry into hardiness, *Journal of Personality & Social Psychology*, **37**, pp. 1-11.

Kobasa, S.C., Maddi, S.R. & Kahn, S. (1982) Hardiness and health: a prospective study, *Journal of Personality & Psychology*, **41**, pp. 168-177.

Kolla, B.P. & Auger, R.R. (2011) Jet lag and shift work sleep disorders: how to help reset the internal clock, *Cleveland Clinic Journal of Medicine*, **78** (10), pp. 675-684.

Krupp, L.B., LaRocca, N.G., Muir-Nash, J. & Steinberg, A.D. (1989) The fatigue severity scale. Application to patients with multiple sclerosis and systemic lupus erythematosus, *Archives of Neurology*, **46** (10), pp. 1121-1123.

Kudielka, B.M. & Kirschbaum, C. (2005) Sex differences in HPA axis responses to stress: a review, *Biological Psychology*, **69**, pp. 113-132.

Kurtz, D.L. (2012) Roll call and the second shift: the influences of gender and family on police stress, *Police Practice & Research*, **13** (1), pp. 71-86.

Kutlu, R., Çivi, S. & Kirschbaum, C. (2005) The assessment of quality of life and depression among police officers, *Türkiye Klinikleri Tıp Bilimleri Dergisi*, **29**, pp. 8-15.

Labyak, S., Lava, S., Turek, F. & Zee, P. (2002) Effects of shiftwork on sleep and menstrual function in nurses, *Health Care for Women International*, **23** (6-7), pp. 703-714.

Lammers-van der Holst, H.M. & Kerkhof, G.A. (2015) Shift work tolerance and the importance of sleep quality: a study of police officers, *Biological Rhythm Research*, **46** (2), pp. 257-264.

Laposky, A.D., Bass, J., Kohsaka, A. & Turek, F.W. (2008) Sleep and circadian rhythms: key components in the regulation of energy metabolism, *FEBS Letters*, **582** (1), pp. 142-151.

Lauer, A. (1995) Flexible rostering guidelines, *Commissioner's Notice of 1995*, **3**, pp. 2 - 8.

Lavie, P., Tzischinsky, O., Epstein, R. & Zomer, J. (1992) Sleep-wake cycle in shift workers on a "clockwise" and "counter-clockwise" rotation system, *Israel Journal of Medical Sciences*, **28** (8-9), pp. 636-644.

Lawrence, R.A. (1984) Police stress and personality factors: a conceptual model, *Journal of Criminal Justice*, **12**, pp. 247-263.

Lazarus, R.S. & Folkman, S. (1984) *Stress, Appraisal & Coping*, Springer Publishing, New York, USA.

Lazarus, R.S. & Launier, R. (1978) Stress-related transactions between person and environment, in Pervin, L.A. & Lewis, M., *Perspectives In International Psychology*, Plenum Press, New York, USA.

Le Fevre, M., Matheny, J. & Kolt, G.S. (2003) Eustress, distress and interpretation in occupational stress, *Journal of Managerial Psychology*, **18** (7), pp. 726-744.

Lewy, A.J., Wehr, T.A., Goodwin, F.K., Newsome, D.A. & Markey, S.P. (1980) Light suppresses melatonin secretion in humans, *Science*, **210** (4475), pp. 1267-1269.

Lieu, S.J., Curhan, G.C., Schernhammer, E.S. & Forman, J.P. (2012) Rotating night shift work and disparate hypertension risk in African-Americans, *Journal of Hypertension*, **30** (1), pp. 61-66.

Liira, J., Verbeek, J. & Ruotsalainen, J. (2015) Pharmacological interventions for sleepiness and sleep disturbances caused by shift work, *JAMA*, **313** (9), pp. 961-962.

Lilly, M.M., Pole, N., Best, S.R., Metzler, T. & Marmar, C.R. (2009) Gender and PTSD: What can we learn from female police officers?, *Journal of Anxiety Disorders*, **23** (6), pp. 767-774.

Lin, P.C., Chen, C.H., Pan, S.M., Chen, Y.M., Pan, C.H., Hung, H.C. & Wu, M.T. (2015) The association between rotating shift work and increased occupational stress in nurses, *Journal of Occupational Health*, **57** (4), pp. 307-315.

Lin, S.H., Liao, W.C., Chen, M.Y. & Fan, J.Y. (2014) The impact of shift work on nurses' job stress, sleep quality and self-perceived health status, *Journal of Nursing Management*, **22**, pp. 604-612.

Lin, Y.C., Hsiao, T.J. & Chen, P.C. (2009) Persistent rotating shift-work exposure accelerates development of metabolic syndrome among middle-aged female employees: a five-year follow-up, *Chronobiology International*, **26** (4), pp. 740-755.

Lindauer, R.J., Olff, M., van Meijel, E.P., Carlier, I.V. & Gersons, B.P. (2006) Cortisol, learning, memory, and attention in relation to smaller hippocampal volume in police officers with posttraumatic stress disorder, *Biological Psychiatry*, **59** (2), pp. 171-177.

Lindauer, R.J., Vlieger, E.J., Jalink, M., Olff, M., Carlier, I.V., Majoie, C.B., den Heeten, G.J. & Gersons, B.P. (2004) Smaller hippocampal volume in Dutch police officers with posttraumatic stress disorder, *Biological Psychiatry*, **56** (5), pp. 356-363.

Lindsey, D. (2007) Police fatigue: An accident waiting to happen, *FBI Law Enforcement Bulletin*, **76**, pp. 1-8.

Loge, J.H., Ekeberg, O. & Kaasa, S. (1998) Fatigue in the general Norwegian population: normative data and associations, *Journal of Psychosomatic Research*, **45** (1), pp. 53-65.

Loo, R. (1984) Occupational stress in the law enforcement profession, *Canada's Mental Health*, **31**, pp. 10-13.

Loudoun, R. (2008) Balancing shiftwork and life outside work: do 12-h shifts make a difference?, *Applied Ergonomics*, **39**, pp. 572-579.

Luceno-Moreno, L., Garcia-Albuerne, Y., Talavera-Velasco, B. & Martin-Garcia, J. (2016) Stress in Spanish police force depending on occupational rank, sex, age and work-shift, *Psicothema*, **28** (4), pp. 389-393.

Lucini, D., Di Fede, G., Parati, G. & Pagani, M. (2005) Impact of chronic psychosocial stress on autonomic cardiovascular regulation in otherwise healthy subjects, *Hypertension*, **46** (5), pp. 1201-1206.

Ma, C.C., Andrew, M.E., Fekedulegn, D., Gu, J.K., Hartley, T.A., Charles, L.E., Violanti, J.M. & Burchfiel, C.M. (2015) Shift work and occupational stress in police officers, *Safety & Health at Work*, **6** (1), pp. 25-29.

Mander, B.A., Winer, J.R. & Walker, M.P. (2017) Sleep and human aging, *Neuron*, **94** (1), pp. 19-36.

Manenschijn, L., van Kruysbergen, R.G., de Jong, F.H., Koper, J.W. & van Rossum, E.F. (2011) Shift work at young age is associated with elevated long-term cortisol levels and body mass index, *The Journal of Clinical Endocrinology & Metabolism*, **96** (11), pp. E1862-E1865.

Maranon, R. & Reckelhoff, J.F. (2013) Sex and gender differences in control of blood pressure, *Clinical Science*, **125** (7), pp. 311-318.

Marcoen, N., Vandekerckhove, M., Neu, D., Pattyn, N. & Mairesse, O. (2015) Individual differences in subjective circadian flexibility, *Chronobiology International*, **32** (9), pp. 1246-1253.

Martini, F. & Nath, J. (2009) Blood vessels and circulation, *Fundamentals of Anatomy & Physiology*, Pearson Education Inc., California, USA, pp. 730-43.

Martins, L.C. & Lopes, C.S. (2012) Military hierarchy, job stress and mental health in peacetime, *Occupational Medicine*, **62** (3), pp. 182-187.

Martins, L.C. & Lopes, C.S. (2013) Rank, job stress, psychological distress and physical activity among military personnel, *BMC Public Health*, **13**, p. 716.

Masilamani, R., Bulgiba, A., Chinna, K., Darus, A., Isahak, M., Kandiben, S. & Koh, D. (2013) Prevalence and associated factors of stress in the Malaysian Police Force, *Preventive Medicine*, **57**, pp. S57-S59.

Matteri, R.L., Carroll, J.A. & Dyer, C.J. (2000) Neuroendocrine responses to stress, in Moberg, G.P. & Mench, J.A., *The Biology of Animal Stress*, CABI Publishing, New York, USA.

Matud, M.P. (2004) Gender differences in stress and coping styles, *Personality & Individual Differences*, **37**, pp. 1401-1415.

Mayhew, C. (2001a) *Occupational Health and Safety Risks Faced by Police Officers*, Australian Institute of Criminology, Canberra, Australia.

Mayhew, C. (2001b) *Protecting the Occupational Health & Safety of Police Officers*, Australian Institute of Criminology, Canberra, Australia.

McCammon, S., Durham, T., Allison, E. & Williamson, J. (1988) Emergency workers' cognitive appraisal and coping with traumatic events, *Journal of Traumatic Stress*, **1**, pp. 353-372.

McCarty, W.P., Zhao, J. & Garland, B.E. (2007) Occupational stress and burnout between male and female police officers: are there any gender differences?, *Policing: An International Journal of Police Strategies & Management*, **30** (4), pp. 672-691.

McCranie, E.W., Lambert, V.A. & Lambert, C.E. (1987) Work stress, hardiness and burnout among hospital staff nurses, *Nursing Research*, **36**, pp. 374-378.

Meerlo, P., Sgoifo, A. & Suchecki, D. (2008) Restricted and disrupted sleep: Effects on autonomic function, neuroendocrine stress systems and stress responsivity, *Sleep Medicine Reviews*, **12**, pp. 197-210.

Meier-Ewert, H.K., Ridker, P.M., Rifai, N., Regan, M.M., Price, N.J., Dinges, D.F. & Mullington, J.M. (2004) Effect of sleep loss on C-reactive protein, an inflammatory marker of cardiovascular risk, *Journal of the American College of Cardiology*, **43** (4), pp. 678-683.

Menard, K.S. & Arter, M.L. (2014) Stress, coping, alcohol use and posttraumatic stress disorder among an international sample of police officers: does gender matter?, *Police Quarterly*, **17** (4), pp. 307-327.

Mesas, A.E., Leon-Munoz, L.M., Rodriguez-Artalejo, F. & Lopez-Garcia, E. (2011) The effect of coffee on blood pressure and cardiovascular disease in hypertensive individuals: a systematic review and meta-analysis, *American Journal of Clinical Nutrition*, **94** (4), pp. 1113-1126.

Miller, G.E., Chen, E. & Zhou, E.S. (2007) If it goes up, must it come down? Chronic stress and the hypothalamic-pituitary-adrenocortical axis in humans, *Psychological Bulletin*, **133** (1), pp. 25-45.

Miyauchi, F., Nanjo, K. & Otsuka, K. (1992) [Effects of night shift on plasma concentrations of melatonin, LH, FSH and prolactin, and menstrual irregularity], *Sangyo Igaku*, **34** (6), pp. 545-550.

Mong, J.A. & Cusmano, D.M. (2016) Sex differences in sleep: impact of biological sex and sex steroids, *Philosophical Transactions of the Royal Society of London*, **371** (1688), p. 20150110.

Monk, T.H. (1988) Coping with the stress of shift work, *Work & Stress*, **2**, (pp. 169-72.

Monk, T.H. (2005) The post-lunch dip in performance, *Clinical Journal of Sports Medicine*, **24** (2), pp. e15-23.

Moore-Ede, M.C., Davis, W. & Sirois, W. (2010) *Advantages and Disadvantages of Twelve Hour Shifts: A Balanced Perspective*, Circadian, MA, USA.

Moore, R.Y. (1978) The innervation of the mammalian pineal gland, in R.J. Reiter (ed.), *Progress in Reproductive Biology Volume 4 – The Pineal & Reproduction*, Karger, Basel, Switzerland.

Morash, M., Kwak, D.H. & Haarr, R.N. (2006) Gender differences in the predictors of police stress, *Policing: An International Journal of Police Strategies & Management*, **29** (3), pp. 541-563.

Morash, M., Lee, C.H., Hoffman, V., Cho, S.H. & Haarr, R.N. (2006) Predictors of social and defensive coping to address workplace stressors: a comparison of police in South Korea and the United States, *International Journal of Comparative & Applied Criminal Justice*, **30** (2), pp. 149-176.

Morikawa, Y., Nakagawa, H., Miura, K., Ishizaki, M., Tabata, M., Nishijo, M., Higashiguchi, K., Yoshita, K., Sagara, T., Kido, T., Naruse, Y. & Nogawa, K. (1999) Relationship between shift work and onset of hypertension in a cohort of manual workers, *Scandinavian Journal of Work, Environment & Health*, **25** (2), pp. 100-104.

Morris, C.J., Purvis, T.E., Hu, K. & Scheer, F.A. (2016) Circadian misalignment increases cardiovascular disease risk factors in humans, *Proceedings of the National Academy of Sciences*, **113** (10), pp. E1402-E11.

Morris, M., Scherr, P. & Hebert, L. (2002) Association between blood pressure and cognitive function in a biracial community population of older persons, *Neuroepidemiology*, **21**, pp. 123-130.

Mosendane, T., Mosendane, T. & Raal, F.J. (2008) Shift work and its effects on the cardiovascular system, *Cardiovascular Journal of Africa*, **19** (4), pp. 210-215.

Motohashi, Y., Reinberg, A., Levi, F., Nougier, J., Benoit, O., Foret, J. & Bourdeleau, P. (1987) Axillary temperature: a circadian marker rhythm for shift workers, *Ergonomics*, **30** (9), pp. 1235-1247.

Motohashi, Y. & Takano, T. (1993) Effects of 24-hour shift work with nighttime napping on circadian rhythm characteristics in ambulance personnel, *Chronobiology International*, **10**, pp. 461-470.

Mullington, J.M., Haack, M., Toth, M., Serrador, J.M. & Meier-Ewert, H.K. (2009) Cardiovascular, inflammatory, and metabolic consequences of sleep deprivation, *Progress in Cardiovascular Diseases*, **51** (4), pp. 294-302.

Murphy, L.R. (1984) Occupational stress management: a review and appraisal, *Journal of Occupational Psychology*, **57**, pp. 1-15.

Muzet, A., Nicolas, A., Tassi, P., Dewasmes, G. & Bonneau, A. (1995) Implementation of napping in industry and the problem of sleep inertia, *Journal of Sleep Research*, **4** (S2), pp. 67-69.

Myers, B.L. & Badia, P. (1995) Changes in circadian rhythms and sleep quality with aging: mechanisms and interventions, *Neuroscience & Biobehavioral Reviews*, **19** (4), pp. 553-571.

Myers, M.G. (2004) Effect of caffeine on blood pressure beyond the laboratory, *Hypertension*, **43** (4), pp. 724-725.

Nakajima, Y., Takahashi, T., Shetty, V. & Yamaguchi, M. (2012) Patterns of salivary cortisol levels can manifest work stress in emergency care providers, *The Journal of Physiological Sciences*, **62** (3), pp. 191-197.

National Heart Foundation of Australia (2016) *Guideline for the Diagnosis and Management of Hypertension in Adults - 2016*, National Heart Foundation of Australia, Melbourne, Australia.

Nelesen, R.A., Dar, Y., Thomas, K. & Dimsdale, J.E. (2008) The relationship between fatigue and cardiac functioning, *Archives of Internal Medicine*, **168** (9), pp. 943-949.

Neu, D., Mairesse, O., Hoffmann, G., Dris, A., Lambrecht, L.J., Linkowski, P., Verbanck, P. & Le Bon, O. (2007) Sleep quality perception in the chronic fatigue syndrome: correlations with sleep efficiency, affective symptoms and intensity of fatigue, *Neuropsychobiology*, **56** (1), pp. 40-46.

Newton, J.L., Finkelmeyer, A., Petrides, G., Frith, J., Hodgson, T., Maclachlan, L., MacGowan, G. & Blamire, A.M. (2016) Reduced cardiac volumes in chronic fatigue syndrome associate with plasma volume but not length of disease: a cohort study, *Open Heart*, **3** (1), p. e000381.

Neylan, T.C., Brunet, A., Pole, N., Best, S.R., Metzler, T.J., Yehuda, R. & Marmar, C.R. (2005) PTSD symptoms predict waking salivary cortisol levels in police officers, *Psychoneuroendocrinology*, **30** (4), pp. 373-381.

Neylan, T.C., Metzler, T.J., Best, S.R., Weiss, D.S., Fagan, J.A., Liberman, A., Rogers, C., Vedantham, K., Brunet, A., Lipsey, T.L. & Marmar, C.R. (2002) Critical incident exposure and sleep quality in police officers, *Psychosomatic Medicine*, **64** (2), pp. 345-352.

Ng-A-Tham, J.E. & Thierry, H.K. (1993) An experimental change of speed of rotation of the morning and evening shift, *Ergonomics*, **36**, pp. 51-57.

Nichols, M., Peterson, K., Herbert, J., Alston, L. & Allender, S. (2016) *Australian Heart Disease Statistics 2015*, National Heart Foundation of Australia, Melbourne, Australia.

Norvell, N.K., Hills, H.A. & Murrin, M.R. (1993) Understanding stress in female and male law enforcement officers, *Psychology of Women Quarterly*, **17**, pp. 289-301.

NSW Government (2017) *Work Conditions & Salary*, http://www.police.nsw.gov.au, Accessed on 17/10/2017.

NSW Police Force (2016) *Annual Report 2015-16*, NSW Police Force Public Affairs Branch, Sydney, Australia.

Oginska, H., Pokorski, J. & Oginski, A. (1993) Gender, ageing, and shiftwork intolerance, *Ergonomics*, **36** (1-3), pp. 161-168.

Ognianova, V.M., Dalbokova, D.L. & Stanchev, V. (1998) Stress states, alertness and individual differences under 12-hour shiftwork, *International Journal of Industrial Ergonomics*, **21**, pp. 283-291.

Ohlander, J., Keskin, M.C., Stork, J. & Radon, K. (2015) Shift work and hypertension: Prevalence and analysis of disease pathways in a German car manufacturing company, *American Journal of Industrial Medicine*, **58** (5), pp. 549-560.

Orr, R., Wilson, A.F., Pope, R. & Hinton, B. (2016) *Profiling the routine tasks of police officers*, Bond University, http://epublications.bond.edu.au/tru_conf/26, Accessed on 04/02/2017.

Orth-Gomer, K. (1983) Intervention on coronary risk factors by adapting a shift work schedule to biologic rhythmicity, *Psychosomatic Medicine*, **45** (5), pp. 407-415.

Pan, A., Schernhammer, E.S., Sun, Q. & Hu, F.B. (2011) Rotating night shift work and risk of type 2 diabetes: two prospective cohort studies in women, *PLoS Medicine*, **8** (12), p. e1001141.

Pandi-Perumal, S.R., Srinivasan, V., Spence, D.W. & Cardinali, D.P. (2007) Role of the melatonin system in the control of sleep: therapeutic implications, *CNS Drugs*, **21** (12), pp. 995-1018.

Park, Y.M., Matsumoto, P.K., Seo, Y.J., Cho, Y.R. & Noh, T.J. (2000) Sleep-wake behavior of shift workers using wrist actigraph, *Psychiatry & Clinical Neurosciences*, **54** (3), pp. 359-360.

Patel, M., Lal, S.K., Kavanagh, D. & Rossiter, P. (2011) Applying neural network analysis on heart rate variability data to assess driver fatigue, *Expert Systems With Applications*, **38** (6), pp. 7235-7242.

Patterson, G.T. (2000) Demographic factors as predictors of coping strategies among police officers, *Psychological Reports*, **87** (1), pp. 275-283.

Peacock, B., Glube, R., Miller, M. & Clune, P. (1983) Police officers' responses to 8 and 12 hour shift schedules, *Ergonomics*, **26** (5), pp. 479-493.

Pendergrass, V.E. & Ostrove, N.M. (1984) A survey of stress in women in policing, *Journal of Police Science & Administration*, **12**, pp. 303-309.

Perrier, D.C. & Toner, R. (1984) Police stress: the hidden foe, *Canadian Police College Journal*, **8**, pp. 15-26.

Phillips, B., Magan, L., Gerhardstein, C. & Cecil, B. (1991) Shift work, sleep quality, and worker health: a study of police officers, *The Southern Medical Journal*, **84** (10), pp. 1176-1196.

Pigeon, W.R., Sateia, M.J. & Ferguson, R.J. (2003) Distinguishing between excessive daytime sleepiness and fatigue: toward improved detection and treatment, *Journal of Psychosomatic Research*, **54**, pp. 61-69.

Pilgrim, J.A. (1994) Psychological aspects of high and low blood pressure, *Psychological Medicine*, **24**, pp. 9-14.

Pineles, S.L., Rasmusson, A.M., Yehuda, R., Lasko, N.B., Macklin, M.L., Pitman, R.K. & Orr, S.P. (2013) Predicting emotional responses to potentially traumatic events from pre-exposure waking cortisol levels: a longitudinal study of police and firefighters, *Anxiety Stress Coping*, **26** (3), pp. 241-253.

Pink, B. 2010, *6342.0 - Working Time Arrangements*, Australian Bureau of Statistics, Canberra, Australia, pp. 1-48.

Pires, M.L., Teixeira, C.W., Esteves, A.M., Bittencourt, L.R., Silva, R.S., Santos, R.F., Tufik, S. & Mello, M.T. (2009) Sleep, ageing and night work, *Brazilian Journal of Medical & Biological Research*, **42** (9), pp. 839-843.

Pogrebin, M. & Poole, E. (1991) Police and tragic events: the management of emotions, *Journal of Criminal Justice*, **19**, pp. 395-403.

Prenzler, T. & Hayes, H. (2000) Measuring progress in gender equity in Australian policing, *Current Issues in Criminal Justice*, **12**, pp. 20-38.

Proctor, A. & Bianchi, M.T. (2012) Clinical pharmacology in sleep medicine, *ISRN Pharmacology*, **2012**, p. 914168.

Pruessner, J.C., Wolf, O.T., Hellhammer, D.H., Buske-Kirschbaum, A., von Auer, K., Jobst, S., Kaspers, F. & Kirschbaum, C. (1997) Free cortisol levels after awakening: a reliable biological marker for the assessment of adrenocortical activity, *Life Sciences*, **61** (26), pp. 2539-2549.

Puttonen, S., Harma, M. & Hublin, C. (2010) Shift work and cardiovascular disease - pathways from circadian stress to morbidity, *Scandinavian Journal of Work, Environment & Health*, **36** (2), pp. 96-108.

Puttonen, S., Kivimaki, M., Elovainio, M., Pulkki-Raback, L., Hintsanen, M., Vahtera, J., Telama, R., Juonala, M., Viikari, J.S., Raitakari, O.T. & Keltikangas-Jarvinen, L. (2009) Shift work in young adults and carotid artery intima-media thickness: The Cardiovascular Risk in Young Finns study, *Atherosclerosis*, **205** (2), pp. 608-613.

Rajaratnam, S.M., Barger, L.K., Lockley, S.W., Shea, S.A., Wang, W., Landrigan, C.P., O'Brien, C.S., Qadri, S., Sullivan, J.P., Cade, B.E., Epstein, L.J., White, D.P., Czeisler, C.A., Harvard Work Hours, H. & Safety, G. (2011) Sleep disorders, health, and safety in police officers, *JAMA*, **306** (23), pp. 2567-2578.

Ramey, S.L., Perkhounkova, Y., Moon, M., Budde, L., Tseng, H.C. & Clark, M.K. (2012) The effect of work shift and sleep duration on various aspects of police officers' health, *Workplace Health & Safety*, **60** (5), pp. 215-222.

Reckelhoff, J.F. (2001) Gender differences in the regulation of blood pressure, *Hypertension*, **37** (5), pp. 1199-1208.

Richmond, R.L., Wodak, A., Kehoe, L. & Heather, N. (1998) How healthy are the police? A survey of life-style factors, *Addiction*, **93** (11), pp. 1729-1737.

Rizk, S.A., Sharaf, N.E., Mahdy-Abdallah, H. & ElGelil, K.S. (2016) Some health effects of aircraft noise with special reference to shift work, *Toxicology & Industrial Health*, **32** (6), pp. 961-967.

Rosa, R.R. (1991) Performance, alertness and sleep after 3.5 years of 12 h shifts: A follow-up study, *Work & Stress*, **5**, pp. 107-116.

Rosa, R.R. (1995) Extended workshifts and excessive fatigue, *Journal of Sleep Research*, **4** (S2), pp. 51-56.

Rosa, R.R. & Bonnet, M.H. (1993) Performance and alertness on 8 h and 12 h rotating shifts at a natural gas utility, *Ergonomics*, **36** (10), pp. 1177-1193.

Rosa, R.R. & Colligan, M.J. (1992) Application of a portable test battery in the assessment of fatigue in laboratory and worksite studies of 12-hour shifts, *Scandinavian Journal of Work, Environment & Health*, **18** (2), pp. 113-115.

Rosa, R.R., Colligan, M.J. & Lewis, P. (1989) Extended workdays: Effects on performance and ratings of fatigue and alertness, *Behaviour Research Methods, Instruments & Computers*, **17**, pp. 6-15.

Rosenman, R., Tennekoon, V. & Hill, L.G. (2011) Measuring bias in self-reported data, *International Journal of Behavioural & Healthcare Research*, **2** (4), pp. 320-332.

Roskies, E. & Lazarus, R.S. (1980) Coping theory and the teaching of coping skills, in Davidson, P.O. & Davidson, S.M., *Behavioural Medicine: Changing Health Lifestyles*, Brunner/Mazel, New York, USA.

Roskoden, F.C., Kruger, J., Vogt, L.J., Gartner, S., Hannich, H.J., Steveling, A., Lerch, M.M. & Aghdassi, A.A. (2017) Physical Activity, Energy Expenditure, Nutritional Habits, Quality of Sleep and Stress Levels in Shift-Working Health Care Personnel, *PLoS One*, **12** (1), p. e0169983.

Roth, S. & Cohen, L.J. (1986) Approach, avoidance and coping with stress, *American Psychologist*, **41**, pp. 813-819.

Sack, R.L., Auckley, D., Auger, R.R., Carskadon, M.A., Wright, K.P., Jr., Vitiello, M.V., Zhdanova, I.V. & American Academy of Sleep, M. (2007) Circadian rhythm sleep disorders: part I, basic principles, shift work and jet lag disorders. An American Academy of Sleep Medicine review, *Sleep*, **30** (11), pp. 1460-1483.

Safe Work Australia (2013) *The Incidence of Accepted Workers' Compensation Claims for Mental Stress in Australia*, Safe Work Australia, Canberrra, Australia.

Safe Work Australia (2015) *The Cost of Work-Related Injury & Illness for Australian Employers, Workers & the Community*, Safe Work Australia, Canberra, Australia.

Safe Work Australia (2016) *A Comparison of Work-Related Injuries Among Shiftworkers and Non-Shiftworkers*, Safe Work Australia, Canberra, Australia.

Sakata, K., Suwazono, Y., Harada, H., Okubo, Y., Kobayashi, E. & Nogawa, K. (2003) The relationship between shift work and the onset of hypertension in male Japanese workers, *Journal of Occupational & Environmental Medicine*, **45** (9), pp. 1002-1006.

Saksvik, I.B., Bjorvatn, B., Harvey, A.G., Waage, S., Harris, A. & Pallesen, S. (2011a) Adaptation and readaptation to different shift work schedules measured with sleep diary and actigraphy, *The Journal of Occupational Health Psychology*, **16** (3), pp. 331-344.

Saksvik, I.B., Bjorvatn, B., Hetland, H., Sandal, G.M. & Pallesen, S. (2011b) Individual differences in tolerance to shift work--a systematic review, *Sleep Medicine Reviews*, **15** (4), pp. 221-235.

Sallinen, M., Harma, M., Mutanen, P., Ranta, R., Virkkala, J. & Muller, K. (2003) Sleep-wake rhythm in an irregular shift system, *Journal of Sleep Research*, **12** (2), pp. 103-112.

Sallinen, M. & Kecklund, G. (2010) Shift work, sleep and sleepiness - differences between shift schedules and systems, *Scandinavian Journal of Work, Environment & Health*, **36** (2), pp. 121-133.

Samaha, E., Lal, S., Samaha, N. & Wyndham, J. (2007) Psychological, lifestyle and coping contributors to chronic fatigue in shift-worker nurses, *Journal of Advanced Nursing*, **59** (3), pp. 221-232.

Scheer, F.A., Hilton, M.F., Mantzoros, C.S. & Shea, S.A. (2009) Adverse metabolic and cardiovascular consequences of circadian misalignment, *Proceedings of the National Academy of Sciences*, **106** (11), pp. 4453-4458.

Senjo, S.R. (2011) Dangerous fatigue conditions: a study of police work and law enforcement administration, *Police Practice & Research*, **12** (3), pp. 235-252.

Sfreddo, C., Fuchs, S.C., Merlo, A.R. & Fuchs, F.D. (2010) Shift work is not associated with high blood pressure or prevalence of hypertension, *PLoS One*, **5** (12), p. e15250.

Shahid, A., Shen, J. & Shapiro, C.M. (2010) Measurements of sleepiness and fatigue, *Journal of Psychosomatic Research*, **69**, pp. 81-89.

Shane, J.M. (2010) Organizational stressors and police performance, *Journal of Criminal Justice*, **38**, pp. 807-818.

Shao, M.F., Chou, Y.C., Yeh, M.Y. & Tzeng, W.C. (2010) Sleep quality and quality of life in female shift-working nurses, *Journal of Advanced Nursing*, **66** (7), pp. 1565-1572.

Shen, J., Botly, L.C., Chung, S.A., Gibbs, A.L., Sabanadzovic, S. & Shapiro, C.M. (2006) Fatigue and shift work, *Journal of Sleep Research*, **15** (1), pp. 1-5.

Shen, J. & Dicker, B. (2008) The impacts of shiftwork on employees, *The International Journal of Human Resource Management*, **19**, pp. 392-405.

Sherwood, A., Routledge, F.S., Wohlgemuth, W.K., Hinderliter, A.L., Kuhn, C.M. & Blumenthal, J.A. (2011) Blood pressure dipping: ethnicity, sleep quality, and sympathetic nervous system activity, *American Journal of Hypertension*, **24** (9), pp. 982-988.

Sherwood, A., Steffen, P.R., Blumenthal, J.A., Kuhn, C. & Hinderliter, A.L. (2002) Nighttime blood pressure dipping: the role of the sympathetic nervous system, *American Journal of Hypertension*, **15** (2), pp. 111-118.

Shiel, W. (2012) *Biorhythms*, http://www.medicinenet.com, Accessed on 25/09/2012.

Sigler, R.T. & Wilson, C.N. (1988) Stress in the work place: comparing police stress with teacher stress, *Journal of Police Science & Administration*, **16**, pp. 151-162.

Skarfors, E.T., Lithell, H.O. & Selinus, I. (1991) Risk factors for the development of hypertension: a 10-year longitudinal study in middle-aged men, *Journal of Hypertension*, **9** (3), pp. 217-223.

Smith, L., Folkard, S., Tucker, P. & Macdonald, I. (1998) Work shift duration: a review comparing eight hour and 12 hour shift systems, *Occupational & Environmental Medicine*, **55** (4), pp. 217-229.

Smith, S.S., Kilby, S., Jorgensen, G. & Douglas, J.A. (2007) Napping and nightshift work: effects of a short nap on psychomotor vigilance and subjective sleepiness in health workers, *Sleep & Biological Rhythms*, **5**, pp. 117-125.

Sookoian, S., Gemma, C., Fernandez Gianotti, T., Burgueno, A., Alvarez, A., Gonzalez, C.D. & Pirola, C.J. (2007) Effects of rotating shift work on biomarkers of metabolic syndrome and inflammation, *Journal of Internal Medicine*, **261** (3), pp. 285-292.

Spiegel, K., Leproult, R. & Van Cauter, E. (1999) Impact of sleep debt on metabolic and endocrine function, *Lancet*, **354** (9188), pp. 1435-1439.

Steiger, A. (2002) Sleep and the hypothalamo-pituitary-adrenocortical system, *Sleep Medicine Reviews*, **6** (2), pp. 125-138.

Steinheider, B. & Wuestewald, T. (2008) From the bottom-up: sharing leadership in a police agency, *Police Practice & Research*, **9** (2), pp. 145-163.

Stępka, E. & Basinska, M.A. (2014) [Chronic fatigue and strategies of coping with occupational stress in police officers], *Medycyna Pracy*, **65** (2), pp. 229-238.

Stokowski, L.A. (2012) Help me make it through the night (shift), *Ohio Nurses Review*, **87** (2), pp. 12-16.

Su, T.C., Lin, L.Y., Baker, D., Schnall, P.L., Chen, M.F., Hwang, W.C., Chen, C.F. & Wang, J.D. (2008) Elevated blood pressure, decreased heart rate variability and incomplete blood pressure recovery after a 12-hour night shift work, *Journal of Occupational Health*, **50** (5), pp. 380-386.

Suls, J. & Fletcher, B. (1985) The relative efficacy of avoidant and nonavoidant coping strategies: a meta-analysis, *Health Psychology*, **4** (3), pp. 249-288.

Suter, P.M., Maire, R., Holtz, D. & Vetter, W. (1997) Relationship between self-perceived stress and blood pressure, *Journal of Human Hypertension*, **11** (3), pp. 171-176.

Suwazono, Y., Dochi, M., Oishi, M., Tanaka, K., Kobayashi, E. & Sakata, K. (2009) Shiftwork and impaired glucose metabolism: a 14-year cohort study on 7104 male workers, *Chronobiology International*, **26** (5), pp. 926-941.

Suwazono, Y., Dochi, M., Sakata, K., Okubo, Y., Oishi, M., Tanaka, K., Kobayashi, E. & Nogawa, K. (2008) Shift work is a risk factor for increased blood pressure in Japanese men: a 14-year historical cohort study, *Hypertension*, **52** (3), pp. 581-586.

Suzuki, K., Ohida, T., Kaneita, Y., Yokoyama, E., Miyake, T., Harano, S., Yagi, Y., Ibuka, E., Kaneko, A., Tsutsui, T. & Uchiyama, M. (2004) Mental health status, shift work, and occupational accidents among hospital nurses in Japan, *Journal of Occupational Health*, **46** (6), pp. 448-454.

Szalajko, M.P. 2005, 'Sex discrimination and sexual harassment within the New South Wales Police: has anything changed?', Charles Sturt University, New South Wales, Australia.

Takahashi, M. (2003) The role of prescribed napping in sleep medicine, *Sleep Medicine Reviews*, **7** (3), pp. 227-235.

Tamagawa, R., Lobb, B. & Booth, R. (2007) Tolerance of shift work, *Applied Ergonomics*, **38** (5), pp. 635-642.

Tang, T.L. & Hammontree, M.L. (1992) The effects of hardiness, police stress and life stress on police officers' illness and absenteeism, *Public Personal Management*, **21**, pp. 493-510.

Tepas, D.I., Duchon, J.C. & Gersten, A.H. (1993) Shiftwork and the older worker, *Experimental Aging Research*, **19** (4), pp. 295-320.

Terpstra, J. & Schaap, D. (2013) Police culture, stress conditions and working styles, *European Journal of Criminology*, **10** (1), pp. 59-73.

Tharkar, S., Kumpatla, S., Muthukumaran, P. & Viswanathan, V. (2008) High prevalence of metabolic syndrome and cardiovascular risk among police personnel compared to general population in India, *The Journal of the Association of Physicians of India*, **56**, pp. 845-849.

Thayyil, J., Jayakrishnan, T.T., Raja, M. & Cherumanalil, J.M. (2012) Metabolic syndrome and other cardiovascular risk factors among police officers, *North American Journal of Medicine & Science*, **4** (12), pp. 630-635.

Thomas, L. & Krebs, C. (1997) A review of statistical power analysis software, *Bulletin of the Ecological Society of America*, **78**, pp. 128-139.

Thorington, L. (1985) Spectral, irradiance, and temporal aspects of natural and artificial light, *Annals of the New York Academy of Sciences*, **453**, (pp. 28-54.

Torsvall, L. & Åkerstedt, T. (1980) A diurnal type scale: construction, consistency and validation in shift work, *Scandinavian Journal of Work, Environment & Health*, **6** (4), pp. 283-290.

Touitou, Y., Motohashi, Y., Reinberg, A., Touitou, C., Bourdeleau, P., Bogdan, A. & Auzeby, A. (1990) Effect of shift work on the night-time secretory patterns of melatonin, prolactin, cortisol and testosterone, *European Journal of Applied Physiology & Occupational Physiology*, **60** (4), pp. 288-292.

Tucker, P., Smith, L., Macdonald, I. & Folkard, S. (1998) Shift length as a determinant of retrospective on-shift alertness, *Scandinavian Journal of Work, Environment & Health*, **24** (3), pp. 49-54.

Tucker, P., Smith, L., Macdonald, I. & Folkard, S. (1999) Distribution of rest days in 12 hour shift systems: impacts on health, wellbeing, and on shift alertness, *Occupational & Environmental Medicine*, **56** (3), pp. 206-214.

Tucker, P., Smith, L., Macdonald, I. & Folkard, S. (2000) Effects of direction of rotation in continuous and discontinuous 8 hour shift systems, *Occupational & Environmental Medicine*, **57** (10), pp. 678-684.

Tuntiseranee, P., Olsen, J., Geater, A. & Kor-anantakul, O. (1998) Are long working hours and shiftwork risk factors for subfecundity? A study among couples from southern Thailand, *Occupational & Environmental Medicine*, **55** (2), pp. 99-105.

Uehata, T. (1991) Long working hours and occupational stress-related cardiovascular attacks among middle-aged workers in Japan, *Journal of Human Ergology*, **20** (2), pp. 147-153.

Vaitkevicius, P.V., Fleg, J.L., Engel, J.H., O'Connor, F.C., Wright, J.G., Lakatta, L.E., Yin, F.C. & Lakatta, E.G. (1993) Effects of age and aerobic capacity on arterial stiffness in healthy adults, *Circulation*, **88** (4), pp. 1456-1462.

van Amelsvoort, L.G., Jansen, N.W., Swaen, G.M., van den Brandt, P.A. & Kant, I. (2004) Direction of shift rotation among three-shift workers in relation to psychological health and work-family conflict, *Scandinavian Journal of Work, Environment & Health*, **30** (2), pp. 149-156.

van Amelsvoort, L.G., Schouten, E.G. & Kok, F.J. (1999) Duration of shiftwork related to body mass index and waist to hip ratio, *International Journal of Obesity & Related Metabolic Disorders*, **23** (9), pp. 973-978.

Van Cauter, E., Plat, L., Leproult, R. & Copinschi, G. (1998) Alterations of circadian rhythmicity and sleep in aging: endocrine consequences, *Hormone Research*, **49** (3-4), pp. 147-152.

Van Cauter, E., Spiegel, K., Tasali, E. & Leproult, R. (2008) Metabolic consequences of sleep and sleep loss, *Sleep Medicine*, **9** (1), pp. S23-S28.

Van Dijk, F.J. & Swaen, G.M. (2003) Fatigue at work, *Occupational & Environmental Medicine*, **60**, pp. i1-i2.

Van Dongen, H.P. (2006) Shift work and inter-individual differences in sleep and sleepiness, *Chronobiology International*, **23** (6), pp. 1139-1147.

van Kempen, E.E., Kruize, H., Boshuizen, H.C., Ameling, C.B., Staatsen, B.A. & de Hollander, A.E. (2002) The association between noise exposure and blood pressure and ischemic heart disease: a meta-analysis, *Environmental Health Perspectives*, **110** (3), pp. 307-317.

Vasquez-Trespalacios, E.M., Palacio-Jaramillo, V., Gomez-Parra, M. & Romero-Arrieta, L. (2016) Shift work and work-related stress symptoms in health care workers in a tertiary hospital in Medellin, Collombia: a cross-sectional study, *CES Psicologia*, **9** (2), pp. 28-39.

Vedaa, O., Harris, A., Bjorvatn, B., Waage, S., Sivertsen, B., Tucker, P. & Pallesen, S. (2016) Systematic review of the relationship between quick returns in rotating shift work and health-related outcomes, *Ergonomics*, **59**, (1), pp. 1-14.

Vena, J.E., Violanti, J.M., Marshall, J.R. & Fiedler, R.C. (1986) Mortality of a municipal worker cohort: III police officers, *American Journal of Industrial Medicine*, **10**, pp. 383-397.

Vercoulen, J.H., Swanink, C.M., Fennis, J.F., Galama, J.M., van der Meer, J.W. & Bleijenberg, G. (1994) Dimensional assessment of chronic fatigue syndrome, *Journal of Psychosomatic Research*, **38** (5), pp. 383-392.

Vicente, J., Laguna, P., Bartra, A. & Bailon, R. (2016) Drowsiness detection using heart rate variability, *Medical & Biological Engineering & Computing*, **54** (6), pp. 927-937.

Vik, A.G. & MacKay, R.C. (1982) How does the 12-hour shift affect patient care?, *Journal of Nursing Administration*, **12** (1), pp. 11-14.

Vila, B. (2006) Impact of long work hours on police officers and the communities they serve, *American Journal of Industrial Medicine*, **49** (11), pp. 972-980.

Vila, B. & Kenney, D.J. (2002) Tired cops: the prevalence and potential consequences of police fatigue, *NIJ Journal*, **248**,(pp. 16-21.

Vila, B., Kenney, D.J., Morrison, G. & Reuland, M. (2000) *Evaluating the Effects of Fatigue on Police Patrol Officers: Final Report*, National Criminal Justice Reference Service, Maryland, USA.

Villareal, G., Hamilton, D.A., Petropoulos, H., Driscoll, I., Rowland, L.M., Griego, J.A., Kodituwakku, P.W., Hart, B.L., Escalona, R. & Brooks, W.M. (2002) Reduced hippocampal volume and total white matter volume in posttraumatic stress disorder, *Society of Biological Psychiatry*, **52**, pp. 119-125.

Vining, R.F., McGinley, R.A., Maksvytis, J.J. & Ho, K.Y. (1983) Salivary cortisol: a better measure of adrenal cortical function than serum cortisol, *Annals of Clinical Biochemistry*, **20**, pp. 329-335.

Violanti, J.M., Andrew, M., Burchfiel, C.M., Hartley, T.A., Charles, L.E. & Miller, D.B. (2007) Post-traumatic stress symptoms and cortisol patterns among police officers, *Policing: An International Journal of Police Strategies & Management*, **30**, pp. 189-202.

Violanti, J.M. & Aron, F. (1994) Ranking police stressors, *Psychol Rep*, **75** (2), pp. 824-826.

Violanti, J.M. & Aron, F. (1995) Police stressors: variations in perception among police personnel, *Journal of Criminal Justice*, **23**, pp. 287-294.

Violanti, J.M., Burchfiel, C.M., Hartley, T.A., Mnatsakanova, A., Fekedulegn, D., Andrew, M.E., Charles, L.E. & Vila, B.J. (2009) Atypical work hours and metabolic syndrome among police officers, *Arch Environ Occup Health*, **64** (3), pp. 194-201.

Violanti, J.M., Charles, L.E., Hartley, T.A., Mnatsakanova, A., Andrew, M.E., Fekedulegn, D., Vila, B. & Burchfiel, C.M. (2008) Shift-work and suicide ideation among police officers, *Am J Ind Med*, **51** (10), pp. 758-768.

Violanti, J.M., Fekedulegn, D., Andrew, M.E., Charles, L.E., Hartley, T.A., Vila, B. & Burchfiel, C.M. (2012) Shift work and the incidence of injury among police officers, *Am J Ind Med*, **55** (3), pp. 217-227.

Violanti, J.M. & Marshall, J.R. (1983) The police stress process, *Journal of Police Science & Administration*, **11**, pp. 389-394.

Violanti, J.M., Marshall, J.R. & Howe, B. (1985) Stress, coping and alcohol use: the police connection, *Journal of Police Science & Administration*, **13**, pp. 106-110.

Virkkunen, H., Härmä, M., Kauppinen, T. & Tenkanen, L. (2007) Shift work, occupational noise and physical workload with ensuing development of blood pressure and their joint effect on the risk of coronary heart disease, *Scand J Work Environ Health*, **33** (6), pp. 425-434.

Vogel, M., Braungardt, T., Meyer, W. & Schneider, W. (2012) The effects of shift work on physical and mental health, *J Neural Transm (Vienna)*, **119** (10), pp. 1121-1132.

Vrijkotte, T.G., van Doornen, L.J. & de Geus, E.J. (2000) Effects of work stress on ambulatory blood pressure, heart rate, and heart rate variability, *Hypertension*, **35** (4), pp. 880-886.

Vyas, M.V., Garg, A.X., Iansavichus, A.V., Costella, J., Donner, A., Laugsand, L.E., Janszky, I., Mrkobrada, M., Parraga, G. & Hackam, D.G. (2012) Shift work and vascular events: systematic review and meta-analysis, *BMJ*, **345**, p. e4800.

Waggoner, L.B., Grant, D.A., Van Dongen, H.P., Belenky, G. & Vila, B. (2012) A combined field and laboratory design for assessing the impact of night shift work on police officer operational performance, *Sleep*, **35** (11), pp. 1575-1577.

Waldstein, S.R. & Katzel, L.I. (2005) Stress-induced blood pressure reactivity and cognitive function, *Neurology*, **64**, pp. 1746-1749.

Waters, J. & Ussery, W. (2007) Police stress: history, contributing factors, symptoms and interventions, *Policing: An International Journal of Police Strategies & Management*, **30**, pp. 169-188.

Webb, S.D. & Smith, D.L. (1980) Police stress: a conceptual overview, *Journal of Criminal Justice*, **8**, pp. 251-257.

Webster, J.H. (2014) Perceived stress among police officers: an integrative model of stress and coping, *Policing: An International Journal of Police Strategies & Management*, **37** (4), pp. 839-857.

William, B. & Kannel, M. (1996) Blood pressure as a cardiovascular risk factor: prevention and treatment, *The Journal of the American Medical Association*, **275**, pp. 1571-1576.

Williamson, A.M. & Sanderson, J.W. (1986) Changing the speed of shift rotation: a field study, *Ergonomics*, **29** (9), pp. 1085-1095.

Winwood, P.C., Winefield, A.H. & Lushington, K. (2006) Work-related fatigue and recovery: the contribution of age, domestic responsibilities and shift work, *Journal of Advanced Nursing*, **56**, pp. 438-449.

Wirth, M., Burch, J., Violanti, J., Burchfiel, C., Fekedulegn, D., Andrew, M., Zhang, H., Miller, D.B., Hebert, J.R. & Vena, J.E. (2011) Shiftwork duration and the awakening cortisol response among police officers, *Chronobiol Int*, **28** (5), pp. 446-457.

World Health Organization (2011) *Waist Circumference and Waist-Hip Ratio*, World Health Organization, Geneva, Switzerland.

Worm-Smeitink, M., Gielissen, M., Bloot, L., van Laarhoven, H.W.M., van Engelen, B.G.M., van Riel, P., Bleijenberg, G., Nikolaus, S. & Knoop, H. (2017) The assessment of fatigue: Psychometric qualities and norms for the Checklist individual strength, *J Psychosom Res*, **98**, pp. 40-46.

Yadav, A., Rani, S. & Singh, S. (2016) Working "out of phase" with reference to chronotype compromises sleep quality in police officers, *Chronobiology International*, **33** (2), pp. 151-160.

Yang, H., Haack, M., Gautam, S., Meier-Ewert, H.K. & Mullington, J.M. (2017) Repetitive exposure to shortened sleep leads to blunted sleep-associated blood pressure dipping, *J Hypertens*, **35** (6), pp. 1187-1194.

Yoo, H.L. & Franke, W.D. (2010) Sleep duration, sleep quality and stress on metabolic syndrome among police officers, Journal of Occupational & Environmental Medicine, **55** (1), pp. 99-103.

Yuan, S.C., Chou, M.C., Chen, C.J., Lin, Y.J., Chen, M.C., Liu, H.H. & Kuo, H.W. (2011) Influences of shift work on fatigue among nurses, *Journal of Nursing Management*, **19** (3), pp. 339-345.

Zeitzer, J.M., Dijk, D.J., Kronauer, R., Brown, E. & Czeisler, C. (2000) Sensitivity of the human circadian pacemaker to nocturnal light: melatonin phase resetting and suppression, *Journal of Physiology*, **526**, pp. 695-702.

Zhao, I. & Turner, C. (2008) The impact of shift work on people's daily health habits and adverse health outcomes, *Australian Journal of Advanced Nursing*, **25** (3), pp. 8-22.

Zhu, J.L., Hjollund, N.H., Boggild, H. & Olsen, J. (2003) Shift work and subfecundity: a causal link or an artefact?, *Occupational & Environmental Medicine*, **60** (9), p. e12.

Zimberg, I.Z., Fernandes Junior, S.A., Crispim, C.A., Tufik, S. & de Mello, M.T. (2012) Metabolic impact of shift work, *Work*, **41** (1), pp. 4376-4383.