THE EFFECTS OF DIFFERENT SHIFT PATTERNS ON NURSES' SLEEP-WAKE BEHAVIOURS IN SELECTED, PRIVATE HEALTHCARE FACILITIES.

BY

EMMA CATHERINE BELL

ORCID: 0000-0002-3197-2334

THESIS

Submitted in fulfilment of the requirement for the Degree of Master of Science
Department of Human Kinetics and Ergonomics

Rhodes University

Makhanda (Grahamstown), South Africa, 2022

Supervisor: Dr. Jonathan Davy

Co-Supervisor: Mr. Andrew Todd

Declaration

I, Emma Catherine Bell, hereby declare that this thesis is based on original work (except where referenced otherwise) and that neither the whole work, nor has any part of it has been, or is to be submitted for another degree at Rhodes University or in any other university.

I authorise the university to use the contents of this work for research purposes.

Abstract

Nurses are required to work shifts to provide 24-hour care, in which they complete physically and mentally demanding tasks. The length and type of shifts, particularly night shifts interfere with the natural sleep-wake behaviours, leading to extended wakefulness and overall reduced sleep, and increase the likelihood of sleepiness during subsequent shifts. This can in turn affected various cognitive processes such attention, vigilance and alertness, which are necessary during the care process. Sleepiness as a result of working shifts has also been associated with an increased risk accidents and error during the delivery of care. Given the unique demands and ways in which workplaces are structured, each context arranges its shifts in unique ways and thus, in order to determine how to manage the effects of shift work, it is important to understand how it affects self-reported fatigue and sleep, of, in this case, nurses. While there has been extensive research on this in the global north, to date, there has been limited research aimed at examining the effects of shift work on nurses' sleep-wake behaviours and fatigue in the South African context. Therefore, the aim of this study is to characterise shift arrangements in selected private facilities and explore its effects on private healthcare nurses.

This study adopted a cross-sectional, survey design using an amended version of Standard Shiftwork Index. The questionnaire included demographic and shift details and explored the impact of the shift systems on nurse sleep-wake behaviours and disturbances and fatigue and workload. It was distributed among shift working nurses registered with the South African Nursing Council across three selected, private, healthcare facilities in the Eastern Cape, over a two-month period. The responses were analysed with descriptive and inferential statistics, with open-ended questions analysed using a thematic analysis.

A total of 51 nurses completed the survey. Nurses worked 12-hour shifts which included night shifts and day shifts with fixed start and end times. Over time was commonly reported and generally, nurses reported having very little control over their shift arrangements. Overall, nurses slept less than what they reported they needed on duty days, with nurses working both day and night shifts reporting to sleep less than the globally recommended required sleep. This was compensated for by longer sleep durations during days off. The data collection revealed that three different shift arrangements were in use, including permanent day shifts, permanent night shifts and rotating shift work including nights, with permanent night nurses working significantly more consecutive shifts (seven) than the other two shift types and having significantly

more days off (seven) as well. While there were no significant differences in self-reported sleep across the three shift types, permanent night nurses were found to have the shortest sleep. During days off, rotating nurse reported significantly longer sleep times compared to day shift workers which may point to the need to catch up from sleep debt. Rotating nurses experienced the greater total disturbances to their sleep than permanent day and permanent night shift nurses. While not statistically significant, it may point to the fact that rotating shift workers could not obtain regularly timed sleep (due to having to change their schedules) compared to permanent day and night nurses. Workload (physical, emotional, mental and time pressure) did not differ between the shifts (day or night) or the shift types, but did reflect a heavier workload, possibly due to the data collection occurring during the 5th wave of the COVID 19 pandemic.

This study highlights that nurses in private healthcare facilities are working extended hours which were associated with reduced total sleep, irrespective of the nature of the shift, with rotating shift nurses experiencing some degree of greater disturbances to their sleep. The number, duration speed and direction of the shifts of rotating nurses needs to be explored further, whilst also exploring the influence of individual factors on sleep-wake behaviours of nurses. It may be beneficial for the healthcare facilities to implement fatigue management strategies to mitigate the negative impacts of shift work, given the impact that this may impact the delivery of care.

Acknowledgments

I would like to extend my sincere gratitude to all of those who contributed to this research.

Firstly, to my supervisor, Dr. Jonathan Davy. This journey could not have been completed without your endearing support and care. You have been a great supervisor and mentor throughout this degree. Your hard work and dedication to your students is truly inspiring. Thank you for your guidance and support, not only with this degree but in life as well. It has been an honour to work with you. I have learnt a great deal from you and will be forever grateful.

To my co-supervisor, Andrew Todd, thank you for your input and guidance throughout this process.

I would like to thank ARMSCOR, my funder for 2021, for making part of this degree possible.

To all the academic staff at Rhodes University who aided me throughout this process. A special thanks to Elron Fouten; I am extremely appreciative of your guidance.

To my family, your never-ending love and all-round support carried me through this process. You gave me the strength to carry on despite the challenges.

A special thanks to my mom, my inspiration for the study, and my brother Jonathan. Without your knowledge and expertise, I would not have been able to complete this degree.

To my friends who always accompanied me on my late nights and long hours to do my work, I appreciate you all.

Table of Contents

List of Tables

List of Figures

Acronyms

CR	Circadian Rhythm
EN	Enrolled Nurse
ENA	Enrolled Nurse Auxiliary
IOM	Institute of Medicine
ILO	International Labour Organisation
IQR	Interquartile Ranges
MEQ	Morningness-Eveningness Questionnaire
NASEM	National Academies of Sciences, Engineering and Medicine
NHI	National Health Insurance
NREM	Non-Rapid Eye Movement
REM	Rapid Eye Movement
RN	Registered Nurse
SANC	South Africa Nursing Council
SN	Staff Nurse
SSI	Standard Shiftwork Index
SSICFS	Standard Shiftwork Index Chronic Fatigue Scale
SWS	Slow Wave Sleep
WHO	World Health Organisation

CHAPTER I
INTRODUCTION

1.1. BACKGROUND

Nurses are an integral part of the healthcare system and instrumental in providing and maintaining quality care (Klopper *et al*., 2012; Shiffer *et al*., 2018; Wilson, 2002). Nurses complete complex tasks evoking various levels of mental and physical exertion over long periods of time, in a dynamic environment with multiple stakeholders (Barker & Nussbaum, 2011; Carayon & Gurses, 2008; Chen *et al*., 2014; Makoweic-Dąbrowska *et al*., 2007; Schluter *et al*., 2011). Nurses have and continue to face various challenges within their healthcare systems, especially in South Africa. The dual system of private and public healthcare in South Africa results in an unequal distribution of resources. A concerning challenge is a shortage of nurses inadequate to the challenges of a growing and aging population, and the burden of disease (Basu, 2018; Chopra *et al*., 2009; Coetzee *et al*., 2013; Mackintosh *et al*., 2016; Pillay, 2009). This all contributes to the demands placed on nurses' care processes.

An important but often challenging part of working as a nurse in healthcare settings is the necessity to work shift work to provide 24-hour care (Klopper *et al*., 2012; Shiffer *et al*., 2018; Wilson, 2002). Shifts in healthcare are often long (12 hours) and require night work which increases the overall wake time; restricting time for sleep and recovery (Alshahrani *et al*., 2017; Giorgi *et al*., 2017; Querstret *et al*., 2020; Rogers *et al*., 2004; Saville *et al*., 2020; Stimpfel *et al*., 2012). Inadequate recovery because of shift work is driven by changes to nurses' sleep-wake behaviours and circadian misalignment (Alshahrani *et al*., 2017; Giorgi *et al*., 2017; Querstret *et al*., 2020; Rogers *et al*., 2004; Saville *et al*., 2012). This results in shorter sleep of less than seven hours for nurses generally working 12-hour shifts, to less than six hours for rotating and permanent night shift nurses (Geiger-Brown *et al*., 2012; James *et al*., 2020; Molzof *et al*., 2019). Having to work consecutive, disruptive shifts also results in the accumulation of sleep debt which often increases the risk of errors and accidents due to sleepiness and nurses sleeping longer (more than seven hours) on off-duty periods (Geiger-Brown *et al*., 2012; Hirsch-Allen *et al*., 2014; James *et al*., 2020; Wilson *et al*., 2019). However, irrespective of when the sleep occurs, it is often difficult for nurses who are already exposed to long working hours given that they need to attend to social and domestic responsibilities (Korsiak *et al*., 2017; Williamson & Friswell, 2013).

The combination of high workloads, long working hours, sleep loss and daytime (and nighttime) sleepiness as a consequence of shift work, negatively influences overall alertness and vigilance, causes performance decrements and increases risk of error, incidents, and injury on duty (Åkerstedt & Landström, 1998; Ball *et al*., 2017; Costa, 2016; Ganesan *et al*., 2019; Gold *et al*., 1992; James *et al*., 2020; Wright *et al*., 2012). Over time, acute fatigue can develop into chronic fatigue, which is associated with a threat to the health and safety of both nurses and patients, contributing to poor quality care (Banakhar *et al*., 2017; Chaput *et al*., 2018; Deboer *et al*., 2007; Han *et al.*, 2014, Sagaspe *et al*., 2012; Van Dongen *et al*., 2012).

In South Africa, nurses work in a dual system of private and public healthcare (Coetzee *et al.*, 2013; Chopra *et al.*, 2009; Hlafa *et al*., 2019; Klopper *et al.*, 2012; Messenger & Vidal, 2015; Young, 2016). Nursing in South Africa is faced with challenges of poor leadership (Armstrong & Rispel, 2015), maldistribution of resources including finances (Aikman, 2019; De Villiers, 2021) human resources (De Villiers, 2021; Maphumulo & Bhengu, 2019), and poverty and unemployment (De Villiers, 2021), and a quadruple burden of disease (Basu, 2018), in addition to long and unpredictable shifts. (Atallah *et al.*, 2012; Carayon & Gurses, 2008; Stimpfel *et al.*, 2012) during the COVID-19 pandemic.

While there is considerable research globally on the effects of shift work on nurses' sleep and fatigue (Åkerstedt & Wright 2009; Giorgi *et al*., 2017; Querstret *et al*., 2020), there is comparatively limited research on these effects on South African nurses, in either the public and private healthcare sector, and especially within the private sector. Furthermore, while other high-income countries have the ability shifts between 6- and 12-hours in length, shifts in the private sector in South Africa are typically 12-hours, especially night shifts (Basic Conditions of Employment Act, 1997; Burker *et al.,* 2009). As a result, there are knowledge gaps about how shifts are scheduled in private healthcare in South Africa. While there is research comparing different shift lengths and the effects of different shift arrangements other healthcare contexts, the knowledge on shift arrangements in private healthcare subsequent effects on nurses' sleep-wake behaviours is poorly understood, thus warrants investigation.

1.3. RESEARCH AIMS

In light of the above, the aims of this study were two-fold. The first aim was to contextualise the current shift work arrangements of selected private healthcare nurses in South Africa. The second aim was to determine how the different shift

arrangements impacted self-reported sleep-wake behaviours and fatigue of nurses in this context.

1.4. RESEARCH OBJECTIVES

The first objective is to characterise the shift system and the different shift arrangements employed across the three different healthcare facilities. The second objective is to characterise the sleep-wake behaviours of nurses, including sleep duration and sleep disturbances and elucidate the effects of different shift arrangements on these self-reported sleep-wake behaviours and fatigue.

CHAPTER II
REVIEW OF LITERATURE

2.1 INTRODUCTION

Healthcare is a complex, dynamic system comprised of multiple stakeholders, multidisciplinary teams, organisations, specialities, and technologies to promote, restore, and maintain health (Braithwaite *et al.,* 2017; Hignett *et al*., 2013; Khan *et al.,* 2018, White, 2015; World Health Organisation [WHO], 2007). These elements of the healthcare system are important in providing quality care and ensuring global health security (Sturmberg, 2012). The healthcare worker, particularly nurses, needs to be recognised as a vital component of the healthcare system, as healthcare workers are responsible for decision-making for the appropriate use of medical equipment and instruments when providing quality care (Anand & Bärninghausen, 2012).

Quality care, as set out by the Institute of Medicine (IOM) and the National Academies of Sciences, Engineering and Medicine (NASEM), is dependent on safety, effectiveness, person-centredness, timelines (affected by accessibility and affordability of resources), efficiency, and equity being achieved (IOM, 2001; NASEM, 2018). The dynamic nature of healthcare requires continuous re-evaluation and redesign to accommodate emerging needs to ensure that healthcare systems continue to be efficient, effective and sustainable, and are able to provide quality care (Carayon, 2006; Pillay, 2009). The foundation of a well-functioning healthcare system is dependent on the balance between disease prevention through clinical and non-clinical work (service delivery) being achieved, adequate distribution of resources and healthcare workers, and good leadership and governance (Carayon, 2006; Hignett *et al.*, 2013). All levels of the system are required to react adaptively when faced with

challenges to achieve the best emergent solutions for individual and community health (Sturmberg, 2012; Khan *et al.,* 2018).In this study we need to understand the role of nurses and the pressures within the system that affect nurses' sleep wake behaviours and fatigue.

2.2. DEMANDS OF THE NURSING PROFESSION

Globally, nurses make up more than 50% of healthcare workers (76.8% in South Africa), and are considered to play a pivotal role in determining and maintaining the efficiency, effectiveness, and sustainability of healthcare systems (Drennan & Ross, 2019; Englebrecht, *et al*., 2019; Fitzpatrick *et al.,* 1999; Klopper, *et al*., 2012; Pillay, 2009; Wilson, *et al*., 2016). Nursing is a dynamic profession that requires nurses to provide and maintain comprehensive, palliative care to individuals, groups and communities in an environment where the technology, tasks, and workloads are constantly changing (Nursing Act, 2005). Thus, nurses must fulfil multiple roles to deliver quality care. Nursing care is categorised into four methods: functional nursing, individual nursing, team nursing, and primary nursing (Parreria *et al*., 2021). These four work methods are further grouped into task-centred (functional nursing) and person-centred care methods (individual, team and primary nursing) (Parreria *et al*., 2021).

The demands of the nursing are highly dependent on the clinical setting such as the physical work environment, interactions with multidisciplinary teams, and level of care required for patients. Thus, nursing workload is the ratio of demands to resources available (Alghamdi, 2016; Carayon & Gurses, 2008; Putri & Rahayu, 2019). Factors that contribute to nurses' workloads include patient acuity, level of skills and knowledge, non-patient related work, physical, mental and emotional exertion, and the dynamic nature of the care process (Alghamdi, 2016), as well as various organisational factors, giving rise to the 'situation workload' (Carayon & Gurses, 2008). The existing nursing workloads increased exponentially caring for COVID-19 patients between 2020 and 2022, with higher levels of stress (Alegbeleve & Moahmmed, 2020; Joo & Liu, 2021; Nashwan *et al*., 2021).

Nurses' workload can be characterised according to the unit, job, patient, and situation levels, each with its unique set of challenges (Carayon & Gurses, 2008). Nurses are required to perform various tasks during specific shifts (unit-level), where the type and

amount of workload is partially dependent on nurse speciality and type of unit (job-level). Throughout, nurses encounter various patients with various clinical needs, and situations within the healthcare system that contribute to overall nursing workloads and nurse stress (Bai & Ravindran, 2020; Carayon & Gurses, 2008). Building on the situation level, workloads are not only influenced by patients' and patients' family's needs on a micro level, but also (un)supportive peer work environments and/or (in)adequate organisational support on meso and macro levels (Carayon & Gurses, 2008). In terms of these levels, we can consider a workload hierarchy, where situation and patient levels are embedded in the job-level workload, which is further embedded in the unit-level workload (Carayon & Gurses, 2008). The dynamic nature of healthcare increases the complexity of tasks and skills required (Barger *et al*., 2005; Ganesan *et al*., 2019), which may further influence the stress and workloads experienced at different workload levels for nurses. Global health challenges have also greatly increased the nursing existing workloads.

Depending on the speciality, nurses are often exposed to disinfectants/sterilising products, UV and X-ray radiation, and anesthetic gases and other harmful substances associated with negative health outcomes (Burdelak *et al*., 2012; Han *et al.,* 2014; Steege *et al*., 2015). Apart from direct patient care, nurses complete non-nursing tasks (tasks below their scope of practice) such as delivering and retrieving food trays, discharges, referrals, transporting patients, and administrative tasks (Bekker *et al*., 2015). All tasks must be completed during rapid admission and discharge cycles (Rogers *et al*., 2004). Stress levels experienced by nurses increase when there is insufficient time to complete tasks within the required timeframe, known as time pressure (Bogossian et al., 2014, Chabikuli *et al*., 2005; Teng, Hsiao, & Chou, 2010). Increased time pressures may hinder nurses' decision-making abilities, often leading to negative emotions surrounding the quality of patient care and nurse fatigue (Teng *et al.*, 2010).

Considering that nursing is a caring profession and apart from physical care, nurses provide emotional support to patients that is culturally sensitive, proficient, and moral (Aslani & Bahmani, 2022; Khamisa *et al*., 2015), adding to the emotional stress and tiredness experienced by nurses and often linked to nurse burnout and fatigue (Aslani & Bahmani, 2022; Dall'Ora *et al.*, 2020; Stimpfel *et al*., 2012).

Nurses' workloads are also largely influenced by the physical work environment, interactions with multidisciplinary teams and patients, and domestic responsibilities (Carayon & Gurses, 2008; Putri & Rahayu, 2019). In a study by West, Rudge and Mapedzahama (2016), workloads of day and night shift nurses differed in that the hospital at night is less crowded, less noisy, and more flexible than during the day. Additionally, patients are sleeping during the night, thus nurses experience less physical and mental workloads with reduced care required, and they can compete their non-care related tasks without the associated time pressures during the day (West *et al.*, 2016). On the other hand, the shortage of staff at night to deal with confused and aggressive patients, can contribute to added time pressure and emotional stress. Moreover, there is a lack of management presence during the night with less night staff, resulting in more responsibility for night shift nurses (West *et al.*, 2016).

The workloads of nurses are further influenced by various challenges in health systems, both globally and locally. The influence of global challenges will be discussed first, followed by the healthcare challenges nurses face in South Africa.

2.3. GLOBAL HEALTHCARE CHALLENGES

In general, delivery of quality care is complex and is dependent on the healthcare system's capacity to provide care, as well as patients' needs (Carayon, 2006). The provision of care encompasses adequate service delivery, health workforce, health information systems, access to medicines, finances and leadership and governance, known as the "building blocks" of healthcare (IOM, 2001). Global health systems, as established by the United Nations General Assembly, aim to improve health through the Millennium Development Goals (World Health Organisation [WHO], 2015). This needs to be achieved through reducing/eradicating extreme poverty, achieving universal basic education, reducing child and maternal mortality, promoting gender equality and female empowerment, effective disease prevention and treatments, environmental sustainability, and global partnerships towards development (WHO, 2015).

However, quality care provision by nurses is largely influenced by the social determinants of health: social and environmental circumstances that determine the distribution of adequate resources for health at national and local levels (Phillips *et al*., 2020). These determinants include access to nutritious food, care, and primary

caregivers, civic participation, crime and violence, discrimination, employment, environmental conditions, health literacy, housing, income, interpersonal violence, education, and social support (Phillips *et al.*, 2020; Reutter & Kushner, 2010). These social determinants of health are influential in moulding the framework for quality healthcare provision, and ultimately health equity for Global South populations (Phillips *et al.*, 2020).

Efficient healthcare delivery by nurses is highly dependent on the availability and readiness of resources, such as reliable power, water, sanitation, standard procedures regarding infection prevention, and medical equipment, all of which are poorly managed in many Global South countries compared with Global North countries (Cronk & Bartram, 2018; Huttinger *et al*., 2017; IOM, 2001). In addition, studies have emphasised inequalities affecting the quality of care between private and public sectors (Basu *et al*., 2012; Berendes *et al*., 2011). Resource limited countries are challenged with poor hygiene practices, often resulting in healthcare-related or hospital acquired infections, contributing to increasing demands for quality care (Allegrazi *et al*., 2011; Cronk & Bartram, 2018; Huttinger *et al.*, 2017; IOM, 2001).

Research has highlighted that a rise in the growing and aging population has increased the associations between demographic, economic and epidemiological factors contributing to cardiovascular and respiratory diseases, diabetes, and certain cancers (Attallah *et al*., 2012; Catton, 2020; Reynolds *et al*., 2013). This is observed particularly in countries with greater poverty, where 90% of diseases worldwide occur (Da Silva, 2008). An emergent challenge, therefore, is a rise in the costs of healthcare linked to the need and availability of technologies, medication, resources, and labour (including nurses), to address the increasing the demand for quality care (Fitzpatrick *et al.*, 1999; Atallah *et al.*, 2012). While Global North countries may be able to afford the rise in costs, Global South countries are still struggling with limited resources and distribution of resources (Alegbeleye & Mohammed, 2020; Carter, 2019; Yates & Lillie, 2019).

In 2020, COVID-19 was announced as a pandemic and an international public health emergency was declared, which has resulted in dire health and socio-economic consequences around the globe (Gao *et al*., 2020; Visagie & Turok, 2020). Nurses particularly were faced with not having enough information about how to treat the novel

virus, and often had to deal with high unpredictability, a lack of support from hospital and healthcare systems regarding appropriate personal protective equipment and treatments, insufficient isolation units, as well as increased emotional and psychological stress (Alegbeleye & Mohammed, 2020; Joo & Liu, 2021).

One of the biggest challenges to healthcare systems around the world is the continuous shortage of skilled nurses to deal with the pre-existing and current increase in demand for quality care and disease prevention (Atallah *et al.*, 2012; Blaauw *et al*., 2013; Carayon & Gurses, 2008; Marć *et al*., 2019; Reynolds *et al.*, 2013; Pittman, 2013; Yamaguchi *et al*., 2016). With a shortage of 7.2 million healthcare workers between 2013 and 2015, it is estimated that there will be a shortage of seven million nurses by 2030 (Drennen, & Ross, 2019) and 12.5 million by 2035 (Carter, 2019; Marć *et al.*, 2019). This is driven by inter alia arguments that there are less people interested in the nursing profession and WHO predicts that 40% will leave the profession by 2030 (Marć *et al.*, 2019). The nursing population is aging or entering the later stages of their nursing careers (Sherman *et al*., 2013); approximately 60% of nurses are above the age of 40, and almost a third are over 50 years of age, thus nearing retirement (Marć *et al*., 2019; Ryan *et al*., 2019). Although strategies have been implemented to address the global nursing shortage such as training and recruiting new nurses, especially registered nurses, the number of younger nurses enrolled for nursing education is still insufficient to replace the already diminishing, older, nursing workforce (Donley, 2005; Van der Heijden *et al*., 2019).

Another factor affecting the nursing shortage, and ultimately nursing workloads, is nurses' dissatisfaction with their working conditions (Donley, 2005), contributing to nurse turnover and intention to leave (Hayes *et al*., 2012; Lo *et al*., 2018). For hospital nurses, these conditions include excessive workloads due to high patient acuity levels. The intensity of nursing care required is affected by the severity of the patient's illness (Brennan & Daly, 2008), more frequent patient transfers, rapid admission and discharge cycles, poor interpersonal relationships at work, poor organisational climate, lack of team support (Halter *et al*., 2017; Hayes *et al.*, 2012) and miscommunication between healthcare workers hindering the effective and efficient coordination of work (IOM, 2001). Nurses often complain of having to complete tasks outside their scope of practice and of not receiving adequate income for the work they do (Marć *et al.*, 2019).

2.4. NURSING IN SOUTH AFRICA

In South Africa, there are four types of nurses by qualification: a professional or registered nurse (RN/PN), enrolled nurse or staff nurse (EN/SN), an enrolled nurse auxiliary or auxiliary nurse (ENA), and midwives (Nursing Act, 2005). A professional nurse, known as a registered nurse (RN), is defined as "a person who is qualified and competent to independently practice comprehensive nursing in the manner and to the level prescribed and who is capable of assuming responsibility and accountability for such practice", in accordance with the regulations set out in Chapter Two, section two of the South African Nursing Act (Nursing Act, 2005, p. 34). Registered nurses complete a four-year course where they are trained in being primarily responsible for the decision-making, administration of treatments, implementation of nursing care plans, as well as preparing and supporting patients through operative, diagnostic and therapeutic processes, and delegating appropriate tasks to and supervising enrolled nurses and enrolled nurse auxiliaries (Nilsson *et al.*, 2008; Nursing Act, 2005; South African Nursing Council [SANC], 2021; Reynolds *et al.*, 2013).

An enrolled nurse, also referred to as a staff nurse, is defined as "a person educated to practice basic nursing in the manner and to the level prescribed" (Nursing Act, 2005, p. 34; Reynolds *et al.*, 2013). Enrolled nurses perform and maintain general nursing practices that are delegated to them by RN's in accordance with legislation (Nursing Act, 2005)

An enrolled nurse auxiliary, or auxiliary nurse is defined as "a person educated to provide elementary nursing care in the manner and to the level prescribed", (Nursing Act, 2005, p. 34). Auxiliary nurses provide basic nursing care prescribed to them by professional nurses, and aid and support nurses of higher qualifications (Nursing Act, 2005).

A midwife is responsible for comprehensive midwifery and neonatal care through the promotion, maintenance and restoration of health of women and children throughout pregnancy (Nursing Act, 2005). The majority of professional nurses are also midwives (Armstrong & Rispel, 2015).

In South Africa, nursing education is available at 20 of 23 public universities, 12 public sector nursing colleges, one defence force run nursing college, private nursing colleges run by three major private healthcare groups, and profit-based private nursing

schools. The quality of nurse education is largely determined by the educational institutions managed by provincial health departments (Armstrong & Rispel, 2015; Rispel 2015). At a job level, a nurse's workload is characterised by the type of nursing job or speciality (Carayon & Gurses, 2008). Some specialities include community health, emergency, forensic, mental health, oncology and palliative, paediatric, and critical care nurses (SANC, 2021).

2.4.1. South African healthcare challenges

The South African healthcare system can be described as three levels (each with a set of legislation): the national (Department of Health), provincial, and district levels (Aikman, 2019), providing primary, secondary and tertiary care (Melariri *et al.,* 2021) to a country suffering from historical and current social inequality, poverty, unemployment, and the quadruple burden of disease (De Villiers, 2021). Post-Apartheid South Africa aimed at reducing the inequalities in the healthcare system to provide healthcare for those that lack basic municipal and provincial services, giving rise to a dual system of private and public healthcare systems (Coetzee *et al.*, 2013; Chopra *et al.*, 2009; Hlafa *et al*., 2019; Klopper *et al.*, 2012; Messenger & Vidal, 2015; Young, 2016). The private sector provides services to the more affluent population (18%) who can afford medical aid or are self-funding; while public healthcare is provided to the less affluent population (84%) via public hospitals and clinics in rural areas, funded by the government (tax revenues) (Aikman, 2019; Coetzee *et al*., 2013; Hlafa *et al*., 2019; Klopper *et al.*, 2012). While the inequalities between the two sectors discussed below have more negative consequences for the public sector, the negative consequences may manifest challenges for staffing, education, and retention of nurses in the private sector discussed further in finance and staffing challenges. Furthermore, the challenges discussed below give important context into resource management in relation to the provision of care by nurses in South Africa.

Like most African countries, South Africa does not have strong 'building blocks' for quality healthcare, particularly in the public sector (Oleribe *et al*., 2019). Furthermore, rapid urbanisation leading to more of the population settling in urban areas, requires healthcare facilities to function beyond their initial capacity (Maphumulo & Bhengu, 2019); while certain healthcare services, institutions and facilities are still largely physically inaccessible to the vast majority of South Africans (De Villiers, 2021). Three main challenges to the South African healthcare system have been identified as

contributing to the growing quadruple burden on disease, the influence of poverty and unemployment, and systemic and structural issues underpinning poor service delivery (De Villiers, 2021). COVID-19 has further highlighted South Africa's pre-existing social and spatial inequalities in relation to poor hygiene and sanitary measures to deal with the pandemic in rural areas (Visagie & Turok, 2021). A barrier to culturally sensitive care is that, despite the 11 languages recognised within South Africa, communication regarding health is primarily done in English, sometimes preventing effective communication between nurses and patients (De Villiers, 2021).

The challenges to healthcare will be discussed starting with leadership and governance, followed by finances, staffing, poverty and unemployment, and the burden of disease.

2.4.1.1. Leadership and governance

The World Health Organisation (WHO) states that leadership and governance encompass strategic policy frameworks responsible for regulation, accountability, system design, oversight and coalition building of health systems (WHO, 2007). The maldistribution of resources, delays in policy implementation, and the revision of the scope of practices for nurses and regulations for nursing education have previously been attributed to issues of poor management, leadership, and governance in South Africa, particularly by the South African Department of Health, and the South African Nursing Council (Armstrong & Rispel, 2015). Nurses have previously reported self-serving interests of leaders who do not focus on the needs and interests of the nursing profession (Armstrong & Rispel, 2015). Issues linked to an inadequate nursing curriculum, education, student training and selection, and workforce planning challenge the current nursing workforce (Armstrong & Rispel, 2015). Moreover, poor leadership further contributes to the retention of nurses and related nursing shortages, dissatisfaction among nurses, and general poor communication (Alghamdi, 2016).

2.4.1.2. Finances

The lack of financial resources between public and private sectors directly influences the availability of medical equipment and treatments (Aikman, 2019). According to the South African Department of Health in 2015, the total health expenditure consumed by the public health sector was 49.2%, where private healthcare costs increased by 120% between 2005 and 2015, leaving an inequality in the allocation of funds between private and public sector to deal with the challenges faced in healthcare by nurses

(Messenger & Vidal, 2015; Surrender *et al*., 2015). Since then, public hospitals are experiencing a shortage in finances, despite the Department of Health receiving R222.6 billion in the 2019/2020 financial year (Aikman, 2019). Eighty-four percent of the South African population require public health services without health insurance, and yet only half of the allocated health expenditure is spent on public healthcare (De Villiers, 2021). In addition, only 16% of South Africans subscribed to medical aid schemes attended to by the private sector consume 50% of the total health expenditure (Maphumulo & Bhengu, 2019). The financial disparities faced by the healthcare systems are largely attributed to wasteful expenditure and corruption (Aikman, 2019). Although the National Health Insurance (NHI) scheme was created to provide all South Africans with the financial opportunity to quality healthcare, due to the continuing maldistribution of finances to fund the scheme, the NHI is also contributing to the lack of healthcare funding (Aikman, 2019). This maldistribution of financial resources subsequently affects the availability of resources for efficient and effective care, which has led to more citizens seeking care from the private sector within more urbanised areas (Maphumulo & Bhengu, 2019). This puts more strain on the private sector to provide care to a larger population than intended, functioning beyond its capacity (Maphumulo & Bhengu, 2019). As a result, private sectors seek to employ more nurses to deal with the influx of patients, further contributing to staffing inequalities and challenges between public and private sectors (Maphumulo & Bhengu, 2019), discussed below.

2.4.1.3. Staffing

South Africa has been identified as unable to effectively implement human resources for health policies (Van Ryneveld *et al*., 2020). The health sector continues to be chronically understaffed in rural areas (De Villiers, 2021), influencing the nurse-to-patient ratio and subsequent recruitment and retention of nurses at a unit level (Alenzi *et al*., 2019; Atallah *et al.*, 2012; Bogossian *et al*., 2014; Carayon & Gurses, 2008; Englebrecht *et al.*, 2019; Saville *et al*., 2020). Between 2000 and 2010 in South Africa, there was already a ratio of 4.08 nurses providing care to 1000 citizens. There is a further maldistribution of nurses between the private (80%) and public (72%) sectors of the total number nurses required to be employed in both sectors (Barron & Padarath, 2017; Engelbrecht *et al.*, 2020; Maphumulo & Bhengu, 2019; Reynolds *et al.*, 2013). Since then, there has been a decrease to one health professional per 1000

patients (Maphumulo & Bhengu, 2019). Aggravating the nursing shortage is the closure of nursing colleges country wide since the 1990s (Maphumulo & Bhengu, 2019). With the under-resourced public sector, nurses often tend to seek employment in the private sector by moonlighting – working a second job in addition to a primary job (Rispel *et al.,* 2014; Maphumulo & Bhengu, 2019). Nurses sometimes moonlight as agency staff, straddling the public and private sector, in the hopes of increased income, additional/specialised training, and more benefits (Rispel *et al.,* 2014). Moonlighting and agency nursing, however, require nurses to work even longer hours, which may inturn affect their overall health and provision of care (Rispel *et al.,* 2014).

2.4.1.4. Poverty and unemployment

In 2018, South Africa was named the most unequal society globally, due to income and wealth inequality, where approximately 70.9% of the country's wealth is controlled by the top 1% of the South African population (De Villiers, 2021). Although the country has implemented policies such as the affirmative action and Black Economic Empowerment programmes, poverty continues to rise in rural and remote areas among black South African citizens (De Villiers, 2021).

2.4.1.5. Burden of disease

At a patient level, nurses' workload is directly influenced by the treatment required related to the patients' conditions (Carayon & Gurses, 2008). Particularly in South Africa and additional to the global influx of treating diseases mentioned at a global level, nurses are challenged with treating the quadruple burden of diseases linked increased HIV/AIDS, tuberculosis, maternal and child mortality rates, and increased rates of non-communicable diseases – four times greater than most countries (Basu, 2018; Coetzee *et al*., 2013; Chopra *et al*., 2009; Coovadia *et al*., 2009; Macintosh *et al*., 2016). The quadruple burden of disease has been further exacerbated by poor diet, increased transmissions of STIs due to unprotected sexual encounters, alcohol abuse, and interpersonal violence (Hlafa *et al.*, 2019) as well as poor hygiene and sanitation (Maphumulo & Bhengu, 2019). In addition, COVID-19 has also exacerbated nurses' burdens (Gao *et al.*, 2020). Not only are nurses faced with the challenge of caring for infected patients, but they are at risk of being infected themselves, especially vulnerable groups such senior nurses and nurses with co-morbidities (Aslani & Bahmani, 2022).

While still limited, evidence suggests that South African nurses both in private and public healthcare sectors are growing more dissatisfied with the working conditions (and poor remuneration) associated with the increase workload, inadequate resources and staffing, fewer career development opportunities, and poor organisational climate (Khamisa, *et al.*, 2015; Klopper *et al*, 2012). This dissatisfaction has contributed to the increasing intra- (public to private) and inter-migration of healthcare workers in search of more desirable working conditions and higher salaries (Maphumulo & Bhengu, 2019; Schrecker & Labonte, 2004), as well as a shortage of nurses. These challenges associated with the care process and healthcare systems within the country only add to the existing demands and workloads faced by nurses daily.

An important aspect contributing to nurses' workloads is long hours/shift work to provide and maintain 24-hour quality care (Atallah *et al.*, 2012; Carayon & Gurses, 2008). While shifts in high income countries, for example countries in the United Kingdom can be between 6 and 12-hours in length (Brucker *et al.,* 2009), shifts (both the public and private sector) are typically 12-hours in South Africa, especially in the context of night work (Basic Conditions of Employment Act, 1997). Furthermore, the realistic length of shifts for nurses is often unpredictable because of changes in the needs of patients and unanticipated staff changes, resulting in nurses working overtime hours (Stimpfel *et al.*, 2012). Nurses often feel like they have little to no control over their shift system (Chan, 2008). The responsibilities and demands of the nursing profession have a significant impact on nurses' sleep (Owens *et al*., 2017). Furthermore, aspects of shift systems related to sleep-wake behaviours and fatigue increase the risk of errors (administrative, procedural, charting, transcription, and medication) as well as contribute to higher incidences of sleep loss-related motor-vehicle accidents whilst commuting and needlestick injuries (Dembe *et al.*, 2009; Geiger-Brown *et al.*, 2012; Gold *et al.*, 1992; Molzof *et al.*, 2019; Smith-Miller *et al.*, 2014), jeopardising the health and safety of both nurses and patients during the care giving process and once nurses leave work. These risks of errors are associated with reduced attention, vigilance and alertness levels, especially towards the end of a night shift (Geiger-Brown *et al.*, 2012; Seong *et al.*, 2021; Wilson *et al.*, 2019), where workplace safety incidents are estimated to be 13% and 27% higher after 10 and 12 hours respectively (Williamson & Friswell, 2013).

Having introduced that shift work contributes to sleep disruptions and fatigue of nurses, the following section provides insight into what shifts work entails, how sleep is regulated in terms of quality and quantity of sleep and alertness, and ultimately how different forms of shift work interferes with sleep-wake regulation.

2.5. SHIFT WORK

Shift work schedules and extended shifts are common in healthcare, specifically among nurses and are necessary to provide 24-hour care. While there are many definitions, shift work refers to a method of organising work outside of the usual 08h00-17h00 working day, which allows individuals to work one shift after another over a 24-hour period (Arlinghaus *et al*., 2019; ILO, 2004; Lerman *et al*., 2012; Silva *et al*.; 2020; Saksvik *et al.,* 2011; Tucker & Folkard, 2012). Shifts often consist of two or more people/teams on duty with differing starting and ending times for work (Åkerstedt, 1988; Sallinen & Kecklund, 2010; Tucker & Folkard, 2012), allowing for the optimal use of facilities, energy, resources for the growing demand, more flexible working and leisure times, and non-standard workplaces (ILO, 2004; Saleh *et al*., 2018; Sallinen & Kecklund, 2010; Tucker & Folkard, 2012).

It is estimated that 20% of the worldwide working force is involved in shift work (Lee *et al*., 2007; McElroy *et al*., 2020; Min, Min, & Chong Hong, 2019; Paoli, & Merllié, 2001; Parent-Thirion *et al.*, 2017); where another 20% of workers engage in night shift work (Ferri *et al*., 2016). Night work is an integral part of shift work in facilitating around-the-clock services, especially in nursing. The International Labour Conference established night work as “all work which is performed during a period of not less than seven consecutive hours, including the interval from midnight to 5 a.m.” (ILO, 2011, p.45; ILO, 2019, p.15). Including shift work, the length of working hours per week for nurses around the globe ranges between 35-46 hours (Ferri *et al*., 2016; Garde *et al*., 2019, Qiu *et al.,* 2020). In South Africa, the Basic Conditions of Employment Act (1997) regulates working time to 45 hours a week.

Shift work, particularly extended shifts of 12 hours, provides greater continuity of staffing over the 24-hour period and decreases overlaps between shifts (Ball *et al*., 2017), which can be useful considering the shortage of nursing staff (Griffiths *et al*., 2014). Continuity of staffing allows for compressed working weeks and more off-duty days per group of shift nurses, a reduction in costs for employment and overtime

hours; and depending on how these shifts are scheduled, reduces the number of daily shift changes and subsequent handovers (Ball *et al.*, 2017; Barker & Nussbaum, 2011; Costa *et al.*, 2014; Dall'Ora *et al*., 2022; Griffiths *et al.*, 2014; Rogers, 2008; Sallinen & Kecklund, 2010; Smith-Miller *et al*., 2014; Williamson & Friswell, 2013; Wilson *et al.*, 2019). Shift work, however, may have additional administrative costs associated with number of workers employed, training, and higher labour costs (ILO, 2004; Saleh *et al.*, 2018), particularly costs associated with increased sick days/absences, and higher incidences of patient care left undone (Griffiths *et al.*, 2019; James *et al*., 2021). Some studies have highlighted that longer shifts increase costs associated with staffing and overtime (Griffiths *et al.*, 2019; James *et al.*, 2021).

2.5.1. Shift work and sleep

Research looking into the characteristics of shift work has identified various associations between the length and type of shifts with negative physiological, psycho-social and safety outcomes (Harringon, 2001; ILO, 2004; Knauth, 1993; Saleh *et al.*, 2018; Sallinen & Kecklund, 2010; Tucker & Folkard, 2012). These consequences of shift work, especially rotational and night work, have previously been attributed to humans being required to work when biologically inclined to sleep (Costa, 2010; Folkard & Åkerstedt, 2004; Folkard, & Lombardi, 2006; International Labour Organisation [ILO], 2019; Ljevak *et al*., 2020; Monk, 1989; Paterson *et al.*, 2014; Shiffer *et al.*, 2018), and sleep when supposed to be awake and alert (Monk, 1989).

If left unattended, disruptions to the sleep wake cycle may lead to sustained feelings of sleepiness, and fatigue. To fully understand the effects of different kind of shifts on sleep, it is important to firstly understand the mechanisms and purpose of sleep, how it is regulated and the effects of disrupted sleep on humans. This is discussed below.

2.6. SLEEP-WAKE REGULATION

Sleep, a universal behaviour and reversable state in which the organism is unresponsive to the environment whilst in a specific position and place, is characterised by lowered body metabolism, and reduced responsiveness to sensory stimuli (Carskadon & Dement, 2011; Mignot, 2008; Overeem *et al*., 2007). Sleep is critical for energy conservation, cognitive, physiological, and physical restoration and maintenance, information processing, and memory consolidation (Borbély *et al*., 2016; Buysse, 2014; Carrier, 2014; Carskadon & Dement, 2011; Chaput *et al*., 2018;

Didikoglu *et al*., 2019; Eldevik *et al.*, 2013; Jonasdottir *et al*., 2021; Matricciani *et al*., 2017; Mignot, 2008; Overeem *et al*., 2007; Qiu *et al.*, 2020).

The timing of sleep and wake, or the sleep-wake cycle, based on alternating periods of restfulness/arousal and sleep synchronised with the 24-hour day/night cycle, is regulated by two important processes: the circadian process and the sleep homeostatic process illustrated by the two-process model of sleep regulation (see Figure 1) (Borbély, 1982; Borbély & Achermann,1999; Murillo-Rodríguez *et al*., 2019).

2.6.1. The circadian rhythm

The circadian rhythm (CR) is produced by the body's natural circadian clock that oscillates 'loosely' about a 24-hour period (Borbély & Achermann, 1999; Costa, 2010; Deboer *et al*., 2007; Goel *et al*., 2013, Madide, 2003; Lemmer, 2015; Moreno *et al.*, 2019; Wright *et al*., 2012; Van Dongen & Dinges, 2000; Vitaterna *et al*., 2001; Yoo & Kim, 2017) observed through biological and physiological processes such as body temperature/thermoregulation, blood pressure, eating habits, and the timing and release of hormones (notably cortisol and melatonin) for immune and endocrine functions (Aesbach *et al.,* 1997; Borbèly, 1982; Borbèly & Achermann, 1999; Costa, 2010; Crowly *et al.*, 2007; Madide, 2003, Moreno *et al.*, 2019; Wahl *et al*., 2019; Vitaterna *et al.*, 2001).

The circadian clock, independent of prior wake and sleep, is sensitive to changes in external stimuli, particularly light or 'zeitgebers', and synchronises or entrains to the exogenous light/dark cycle (Aesbach *et al.*, 1997; Borbély, 1982; & Borbély & Achermann, 1999; Crowly *et al*., 2007; Goel *et al.*, 2013). Changes in light alert the suprachiasmatic nucleus (SCN) situated in the hypothalamus known as the circadian pace-maker (Aesbach *et al.*, 1997; Borbély, 1982; Borbély & Achermann, 1999). Entrainment of the CR further drives behaviours associated with sleep regulation (Crowly *et al*., 2007; Hirotsu *et al*., 2015; Kervezee *et al*., 2020; Overeem *et al*., 2007; Ramkisoensing & Meijer, 2015; Wahl *et al.*, 2019), enabling the circadian clock to anticipate changes in the environment through negative and positive feedback loops (Hirotsu *et al*., 2015; Kervzee *et al.*, 2018; López-Soto *et al*., 2019; Overeem *et al.*, 2007; Ramkisoensing & Meijer, 2015; Wahl *et al.*, 2019). In addition to natural light stimulus, the circadian clock also responds to exogenous factors such as artificial light, and behaviours such as physical activity, and stimulant, drug, and food intake (Arendt,

2010; Chaput *et al.*, 2018; Goel *et al.*, 2013; Wahl *et al.*, 2019). It is also influenced by individual factors of age, genetics, and chronotype (Chaput *et al.*, 2018; Goel *et al.*, 2013; Wahl *et al.*, 2019).

The circadian clock is responsible for daily fluctuations in attention and alertness that coincide with core body temperature rhythms (Molzof *et al*., 2019). The peak or acrophase occurs in the late afternoon or early evening, a time that is often difficult to initiate sleep in (Wilking *et al.,* 2012). Contrastingly, there are also troughs within the rhythm: the first occurs during the early afternoon and is often referred as the post lunch dip and the second is the nadir which occurs in the early hours of the morning, between 02h00 and 06h00 (Czeisler *et al.,* 1980; Monk, 2005). These periods, but more so the nadir, are characterised by low physiological arousal and sleepiness (Czeisler *et al.,* 1980). The nadir of the CR is presented as heightened alertness levels characterised by increased cortisol levels, initiating wake (Djik *et al*., 2012). On the other hand, the CR changes at night, are associated with decreased alertness levels and increased sleep propensity during the late afternoon and night, with the reduced light stimulus triggering the release of melatonin to prepare the body for sleep (Cajochen *et al.*2003).

The circadian rhythm works together with the homeostatic drive for sleep to promote sleep and wake at the appropriate times of day. The homeostatic drive for sleep is discussed next.

2.6.2. Homeostatic drive for sleep

The homeostatic drive for sleep is a sleep pressure system regulating sleep – the build-up and dissipation of sleep pressure, opposing the circadian process (Borbély & Achermann, 1999). Observed through slow wave sleep (SWS), the stage in which most restorative and strengthening physiological processes take place, non-rapid eye movement, and electro-encephalography, the homeostatic system ensures that sleep propensity accumulates throughout the day and decreases as the body transitions to non-rapid eye movement (NREM) sleep until adequate dissipation of sleep pressure is reached (Aeschbach *et al.*, 1997; Borbély, 1982; Borbély *et al.*, 2016; Carskadon & Dement, 2011; Crowley *et al.*, 2007; Czeisler & Gooley 2007; Deboer, 2018; Kervezee *et al*., 2020; Owens, 2007). Increased time spent awake and/or sleep loss leads to a greater accumulation of sleep propensity (Borbély, 1982).

2.6.3. Two-process model of sleep regulation

The two-process model for sleep regulation in Figure 1 illustrates the relationship between the homeostatic sleep drive and the circadian rhythm (proposed by Borbély in 1982) that regulates the timing of sleep and wake in mammals. Process S represents the homeostatic sleep drive, while process C represents the circadian rhythm (CR), acting paradoxically about a 24-hour period (Borbély, 1982; Borbély *et al.*, 2016; Czeisler & Gooley 2007). In addition, the ultradian process also observed in sleep research, consists of alternating cycles of rapid eye movement (REM) and non-rapid eye movement (NREM) (Borbély & Achermann 1999).

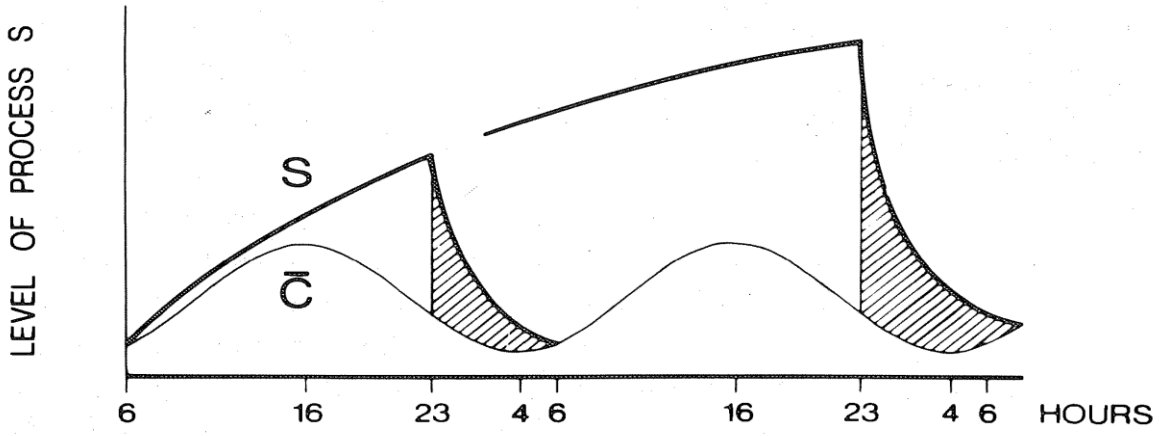

Figure 2: The two-process model for sleep regulation in entrained conditions, where process S represent homeostatic sleep drive and process C represents circadian process (Borbély, 1982)

In entrained conditions, the sleep-wake cycle promotes and maintains wakefulness and cognitive alertness for approximately 16 hours during the day (Cajochen *et al*., 2003). Process C is responsible for maintaining wakefulness during the day, and this promotes sleep during the night when sleep propensity is high (Lavie 1980, as cited in Cajochen *et al.*, 2003). This has been observed through the release of melatonin in correspondence with decreased body temperature (Djik *et al*., 1999; Djik *et al.*, 2012). Process S (sleep propensity) decreases with sleep and wake is initiated with the release of cortisol, in conjunction with increasing body temperature and exposure to light (Djik *et al.*, 2012). Extended wakefulness or being awake during the night, desynchronises the circadian rhythm and homeostatic sleep drive, known as circadian misalignment, increasing sleep pressure (Knauth, 1996; Korompeli *et al.*, 2014; Querstret *et al*., 2020; William & Friswell, 2003; Wright *et al.*, 2012). This is a common

effect of work at night or during the early morning, something discussed in more detail later in this chapter.

2.6.4. Sleep quality and disturbances

For healthy and good quality sleep, previous research has recommended that the average sleep duration for adults be between seven and nine hours daily (Burgess & Eastman, 2006; Carskadon & Dement 2011; Caruso, 2013; Caruso, 2014; Caruso & Hitchcock, 2010; Hirshkowitz *et al.*, 2015; Paruthi *et al.*, 2016). Sleep quality is referred to as perceived deep sleep or self-satisfaction with all aspects of sleep (Edéll-Gustafsson, 2002; Nelson *et al.,* 2021), influenced by sleep duration, sleep efficiency, sleep deprivation, sleep onset latency (delayed sleep onset), sleep fragmentation – short repetitive arousals (Buysse *et al.*, 1988; Chan, 2008; Owens & Matthews, 1998; Shrivastava *et al.,* 2014; Smurra *et al.,* 2001). These aspects of good quality sleep influence the timing and length of sleep, and subsequent sleep efficiency (ratio of total time spent in bed to total sleep time) (Desjardins *et al.,* 2009; Reed & Sacco, 2016; Sahlin *et al.*, 2009).

2.6.5. Nurses' sleep quality and disturbances

Extensive research shows that nurses working night shift have been found to experience greater difficulties in initiating and maintaining sleep, otherwise known as sleep disturbances (Flo *et al.*, 2013; Geiger-Brown *et al.*, 2012; Niu *et al.*, 2017; Seong *et al.*, 2021; Sun *et al.*, 2018); approximately 75% of the shift work population experienced disturbed sleep (Åkerstedt & Wright 2009; Williamson & Friswell, 2013). Sleep disturbances refer to disorders that restrict the initiation and maintenance of sleep, non-restorative sleep, early awakenings, and overall sleep dissatisfaction (Cormier, 1990; Linton *et al.*, 2015). Sleep maintenance for nurses working night shift is interrupted by family members continuing with daily activities, and exposure to exogenous factors of light, noise and ambient temperature during the day (Costa 2016; Niu,et al, 2017, Silva-Costa *et al.*, 2012; West *et al.*, 2016). Egyptian and Greek nurses working nights, reported low to moderate sleep disturbance scores between 20.4 (Saleh *et al.*, 2018) and 21.9 (Korompeli *et al.*, 2013) respectively, higher than Italian nurses' scores of 18.6 and 14.4 (Costa *et al.*, 2014; Ferri *et al.*, 2016). Disruptions to the sleep-wake cycle have been linked to decreased sleep quality (Owens & Matthews, 1998; Shrivastava *et al.*, 2001).

A body of research has shown that shift work, particularly characteristics of shift length, shift regularity, flexibility of shift systems, consecutive shifts, distribution of leisure time/days off, part-time/full-time work, timing of shifts, and shift rotation affect sleep quality, disturbances, and the degree of sleepiness experienced (Dall'Ora et al., 2016; Knauth, 1993; Knauth, 1996; Korompeli *et al.*, 2013; Korompeli *et al.*, 2014; Shao *et al.,* 2010; Tucker & Folkard, 2012). When the total sleep duration is less than six hours, the cumulative sleep loss over consecutive days can result in sleep debt (Dorrian, Paterson, Dawson *et al.,* 2011; Van Dongen *et al.,* 2003). Sleep debt can lead to higher levels of sleep pressure and lowered circadian-regulated alertness, higher (daytime) sleepiness, and a dose-dependent drop in performance ability (Åkerstedt, 1988; Dement & Carskadon, 1982; Duffy *et al.,* 2009; Zion *et al.*, 2019).

Although there are several ways in which shifts can be arranged, there is no optimal shift system design (Barton *et al.,* 1995; Ferguson & Dawson, 2012; ILO, 2016; Knauth, 1993). This is because shift work arrangements have varying effects on workers' sleep-wake behaviours, and daily and social activities (Knauth 1993; Knauth, 1998; Korompeli *et al.,* 2013; Korompeli *et al.,* 2014; Sun *et al.,* 2019). Since the circadian rhythm is naturally synchronised to the exogenous light-dark cycle (Aesbach *et al.*, 1997; Borbély, 1982; & Borbély & Achermann, 1999; Crowly *et al.,*, 2007; Goel *et al.*, 2013), night work (and any other shifts that require wakefulness during the biological night) requires workers to work when biologically inclined to sleep (Costa, 2010; Folkard & Åkerstedt, 2004; Folkard, & Lombardi, 2006; ILO, 2019; Ljevak *et al.,*, 2020; Paterson *et al.*, 2014; Shiffer *et al.*, 2018), and sleep during a period of circadian wake and alertness (Czeisler *et al.*, 1980; Wickwire *et al.,*, 2017). It is this that can often lead the poor quality and insufficient sleep experienced by nurses and other occupations in which shift work is common.

The above-mentioned aspects of shift work schedules affect sleep-wake behaviours in a variety of ways. How these shift characteristics affect sleep quality and disturbances is discussed below, particularly regarding extended shifts of 12 hours, shift rotation and night work. These shift characteristics are introduced and their effects on sleep-wake behaviour discussed. Relevant literature in the context of nursing is integrated as well.

2.7. SHIFT WORK CHARACTERISTICS

2.7.1. Shift length

The duration of shift work is dependent on the nature of work involved, for example workload, level of cognitive resources required to complete tasks, degree of monotony, and the number of available breaks for rest (Dorrian *et al.*, 2011). Working hours can be divided into three or four hours in the case of part-time work but are often divided into daily 12- and 8-hour shifts, or even 16-hour shifts (Costa *et al.*, 2021; Dall'Ora *et al.*, 2016; Kecklund & Axelsson 2016; Rogers *et al*., 2004). Shifts beyond eight hours are considered as extended shifts and should only be scheduled if the workload and risks are appropriate (Knauth, 1993). In a review on typical shift lengths for European nurses, in Denmark shifts were eight hours, between 10 and 11 hours in Finland, and nine hours in Norway (Garde *et al.*, 2019).

Twelve-hour shift nurses, working both day and night shifts, struggle to sleep on duty days/nights (Geiger-Brown *et al.,* 2012; Harris *et al.,* 2015). James and colleagues (2020) found that day shift nurses report sleeping for 6.6 hours on average, similar to other studies where sleep duration was of 6.79 hours (Hirsch-Allen *et al.*, 2014) and 6.7 hours (Molzof *et al.* 2019). This is lower than sleep durations in other studies of 7 hours (Wilson *et al.,* 2019) and higher than one study of 5.8 hours on day shifts (Heath *et al.*, 2019). In a study by Geiger-Brown and colleagues (2012), sleep duration of nurses working 12-hour day shifts ranged between 5.7 and 7.3 hours. Similarly, sleep directly after a night shift is shorter (Costa *et al.*, 2014; Ferreira & De Martino, 2012; Shiffer *et al.*, 2018). In a study by Geiger-Brown and colleagues (2012), Australian nurses working night shifts sleep for five and a half hours after the first shift, similar to the sleep duration of a group of American nurses sleeping for 5.65 hours between two shifts (Hirsch *et al.,* 2014). In contrast, research on other groups of night shift nurses in other contexts shows that, on average, they receive seven hours of sleep (Dorrian *et al.*, 2011; Heath, Dorrian & Coates, 2019; James *et al.*, 2020; Molzof *et al.*, 2019).

Overtime in nursing is a common practice contributing to the overall length of shifts, with nurses often working overtime to complete managerial and administrative tasks (Rogers *et al.*, 2004; Saville *et al.,* 2020; Griffiths *et al.*, 2014; Stimpfel *et al.,* 2012). Together, extended shifts and overtime hours ultimately reduce the amount of time required for adequate rest and recovery post shift (Åkerstedt & Wright 2009;

Williamson & Friswell, 2013, Yun *et al.,* 2021). This increases homeostatic sleep pressure, and subsequent sleep debt and sleepiness.

2.7.2. Shift arrangements and regularity

Shift systems can be scheduled to be fixed/permanent or rotating, with the same group of workers working at the same time every day, or at differing times (Costa *et al.*, 2021; ILO 2004; Silva, Duarte, Torres & Costa, 2020). Shifts can be arranged to be continuous (operates 24 hours over the seven-day period with at least three teams), semi-continuous (operates 24 hours using three teams (3x8) with an interruption such as a weekend), and discontinuous (operates 24 hours using two teams (2x8) with a daily or weekend break) (Costa, 2016; ILO, 1987; Silva & Bastos, 2018; Van Amelsvoort *et al.,* 2004). In nursing, semi-continuous shift systems are preferred as they allow for fewer shifts per week, fewer handovers, and possibly longer or more frequent days off (Costa *et al.*, 2014; Griffiths *et al.*, 2014; Sallinen & Kecklund, 2010; Wilson *et al.*, 2019).

Shift regularity is a further and important consideration when designing shift work. There are three types of shift systems: regular, irregular, and flexible shift systems (Sallinen & Kecklund, 2010). Regular shift systems have the same start and end times which allow for set rest periods and greater opportunities for rest (Gao *et al.,* 2020), whereas irregular shift systems have differing start and end times resulting in unpredictable rest periods (Sallinen & Kecklund, 2010). Flexible shift systems allow shift workers to fix their own working schedules within certain boundaries (ILO, 1987) With greater control in flexible shift systems, there is a lower risk of sleep disturbances as shift workers are better able to adapt their circadian rhythm to their work schedules (Salo *et al.,* 2014). Regular shift systems allow for adequate planning for recovery and daily activities (Zion *et al*., 2018). Previous research, however, has shown that nurses working fixed nights do not receive the recommended seven hours of sleep (Caruso, 2014), where Taiwanese and Australian nurses slept for five hours (Chung *et al.*, 2011; Geiger-Brown *et al.*, 2012), and Korean permanent night nurses slept for 6.5 hours on average (Min *et al.*, 2021).

2.7.3. Shift rotation

Rotating shift systems can be arranged into two-shift (day and night) or three-shift (morning, afternoon, and night) systems (Costa *et al.*, 2021; Kecklund & Axelsson 2016; ILO, 2004; Sallinen & Kecklund, 2010) although 12-hour semi-continuous two-

shift systems are predominantly used in healthcare (Costa *et al.*, 2014; ILO, 2019; Griffiths *et al.*, 2014; Makoweic-Dąbrowska *et al.*, 2000; Sallinen & Kecklund, 2010; Sveinsdóttir, 2006; Wilson *et al.*, 2019). Rotating shifts can be scheduled to rotate clockwise or counterclockwise (Sallinen & Kecklund, 2010; Tucker & Folkard, 2012), resulting in workers adjusting their activity and rest periods due to changes in the start and end times of shifts (Costa, 2003). Rotating shifts require shift workers to adjust daily activity and rest periods (Costa, 2003), further influencing daily physiological functions regulated by the endogenous biological clock (Costa, 2003).

Previous research suggests that clockwise rotating can allow more time for sleep and recovery (Shiffer *et al.*, 2018; Tucker *et al.*, 2000), this rotation is associated with later sleep and wake times or a phase delay (Tucker & Folkard, 2012). On the other hand, counter-clockwise rotating systems may be associated with a reduced amount of time between the end of one shift and the start of the next shift and thus compress work weeks (Knuath & Hornberger, 2003), leading to earlier sleep and wake times (phase advance) (Tucker & Folkard, 2012). This is referred to as the ‘quick return” and is characterised by a short interval between the end of one shift and the start of the next shift (Costa *et al.*, 2014; Dahlgran *et al.*, 2016; Kecklund & Axelsson, 2016; Knuath & Hornberger, 2003; Tucker & Folkard 2012; Vedaa *et al.,* 2015). Quick returns result in restricted time for sleep, and subsequently have been linked to insomnia, excessive sleepiness, and fatigue (Eldevik *et al.*, 2013). This was observed in a study by Shiffer et al. (2018) where nurses on a clockwise rotation (afternoon, morning, night) slept for 10.36 hours, and 4.98 hours in a counterclockwise rotation (afternoon, morning, morning, night), both before a night shift. Similarly, in the same study, nurses slept for 4.98 h (clockwise) and 4.1h (counterclockwise) after a night shift.

Looking at clockwise shift rotations, in a study by Hirsch-Allen and colleagues (2014), nurses slept for 8.47 hours from day to night shifts, 2.5 hours more than in one study going from evening to night shifts (Min *et al.,* 2021), and three hours more than another study going from afternoon to night shifts (Shiffer *et al.*, 2018). The sleep duration of nurses (4.98h) in a clockwise rotation found by Shiffer and colleagues (2018) of 4.98h*,* was similar to the sleep duration found from night shift to a day off of 4.84h found by Hirsch-Allen and colleagues (2014).

In counterclockwise shift systems, one study (Min *et al.*, 2021) found that nurses reported sleeping for 6.8 hours from evening to day shifts, higher than the findings of Shiffer and colleagues (2018) where nurses slept for 5.02 hours between morning and night shifts. In another study, Korean rotating shift nurses slept for 6.8 hours from evening to day shifts. In another study by Shiffer and colleagues (2018) on Italian nurses working both rapid clockwise and counterclockwise rotations, nurses in the clockwise rotating slept on average for 7.40 sleeping for 4.98 hours after a night shift. In the same study (Shiffer *et al.*, 2018), nurses in the counterclockwise rotating slept on average for 6.09 hours, sleeping for 4.1 hours after a night shift.

Due to inadequate time for rest, especially observed in counterclockwise rotations, nurses working rotating nights tend to feel sleepier and less rested before the start of their shifts (Geiger-Brown *et al.*, 2012; Shiffer *et al.*, 2018). In a study on night workers, including nurses, this has been attributed to rotating shift nurses having more challenges maintaining sleep than permanent night shift nurses but less challenges of sleep maintenance than day shift nurses (Karhula *et al.,* 2018). As a possible reason, some studies suggest that rotating nurses exhibit elevated cortisol levels due to continuous circadian stress - inability to promptly adjust to day shift and night shift work making it difficult to initiate and maintain sleep (Korompeli *et al.*, 2014; Niu *et al.*, 2015; Rosa *et al.*, 2019). Additionally, rotating nurses' self-reported sleep has also been attributed to higher levels of stress and mental strain (Edéll-Gustafsson, 2002). With the challenges associated with shift rotation and sleep wake-behaviours discussed above, it is recommended that a rapid and forward rotatin is favoured over backward and slowly rotating shift (Ferguson & Dawson, 2012; Knauth, 1993; Knauth, 1996; Knauth & Hornberger 2003, Lerman *et al.*, 2012, Sallinen & Kecklund, 2010)

2.7.4. Consecutive shifts

A number of reviews have suggested that the number of days worked consecutively should be between five and seven days to maintain performance and safety (Knauth, 1993; Knauth, 1998; Knauth & Hornberger, 2003), and that no more than two to three consecutive shifts should be worked (Chen *et al.*, 2014; Costa *et al.*, 2021). This is attributed to the fact that nurses working consecutive shifts are receiving too little sleep (less than 7 hours) irrespective of the shift that they work (Geiger-Brown *et al.,* 2012; Halter & Sahu, 2015). Nurses in a study by Halter and Sahu (2015) in a rotating three-shift system slept on average for 6.06 (morning), 6.51 (afternoon), and 4.98 hours

(night) on the last shift. Like studies looking at 12-hour two-shift systems, nurses' sleep decreased from 5.5 hours to 5.1 hours from the second to third consecutive night shift (Geiger Brown *et al.,* 2012), and from approximately 7.5 to 5.18 hours between the third and fourth consecutive day shifts (Rhéaume and Mullen, 2018). Rhéaume and Mullen (2017) found a 20% decrease in sleep duration between the first and fourth consecutive day shifts, contrary to Geiger-Brown and colleagues (2012) where sleep duration increased from 5.7 to 7.3 hours from the first to third consecutive 12-hour day shift. In a study by Hirsch-Allen and colleagues, in comparison with the previous two studies, the sleep duration (6.79 hours) was higher between two consecutive day shifts and similar between two consecutive night shifts (5.68 hours).

Studies have shown that cumulative sleep loss of four to six hours over consecutive days, also referred to as sleep debt, requires nurses to sleep longer when there is more time available for sleep, for example, on days off, where nurses "catch up on sleep" (Dorrian *et al.*, 2011; Overeem *et al.*, 2007; Wilson *et al.*, 2019). In a study on American nurses, regardless of the shift work, nurses were sleeping for eight hours, almost two hours more on off days than on duty days (James *et al.*, 2020).

In contrast, it has been argued that more consecutive night shifts allow for the entrainment of the circadian rhythm to night work, leading to better quality sleep (Bjovatn *et al*., 2006), where those working night shift need at least four consecutive shifts to adjust their circadian rhythms (Niu *et al.*, 2015). In another study, there were no differences in sleep duration and quality found with the different number of consecutive night shifts worked (Garde *et al.*, 2020). In a review of European nurses, more Norwegian nurses worked five consecutive night shifts compared with nurses from Denmark and Finland (Garde *et al.*, 2019). In a study on Korean nurses, permanent night nurses worked two to four consecutive night shifts followed by two or more days off and typically slept for six and a half hours (Seong et al., 2021).

2.7.5. Distribution of leisure and recovery time

Time off between two consecutive shifts is important for overall recovery and social and family obligations (Knauth, 1993). Previous research has found that nurses working night shifts were sleeping five hours on duty days, where day shift nurses are more likely to sleep longer (>seven hours) on days off. Differences in sleep obtained on duty days and days off has commonly been observed for various reasons (Dorrian

et al., 2011; Harris *et al.*, 2015; James *et al.*, 2020; Madide 2003). One reason is that twelve-hour shifts (the extended shift) results in extended periods of wake and shortened periods of recovery post shift (Knauth, 2007). Rest periods less than 11 hours, for example eight hours, do not allow enough time between shifts for daily activities such as commuting, domestic chores, and caring for dependents, which ultimately decrease the time available between for sleep (Costa, 2010; Haltar & Sahu, 2015; Knauth, 1998). In a review by Rosa and colleagues (2019), it was highlighted that nurses working night shifts often wake up earlier, for example at 13h00, to consume a meal, or to spend time with family, further shortening nurses' sleep. In a review by Vedaa and Colleagues (2015), and like other studies (Costa *et al.*, 2014), quick returns of 10 hours or less are associated with shorter sleep durations and more difficulties in initiating and maintaining sleep (Knauth, 1998).

Therefore, it is recommended that rest period are no less than 11 hours per 24 hours (Ferguson & Dawson, 2012; Knauth, 1993; Knauth, 1996; Knauth, 1998; Knauth & Hornberger 2003, Lerman *et al.*, 2012, Sallinen & Kecklund, 2010). Furthermore, due to various responsibilities that nurses have post-shift, it has been suggested that nurses require 16 hours of leisure time in order to achieve the recommended seven to eight hours of sleep (Kurumatani *et al.*, 1994, as cited in Haluza, Schmidt, & Blasche, 2018).

2.7.6. Shift timing

The timing of shifts informs the start and end times for shifts to follow in rotating shift systems, as well as how much sleep can be obtained pre- and post-shift (Kecklund & Åkerstedt, 1995). In nursing, common shift times for morning/day shifts start between 06h00 and 08h00 and end between 14h00 and 19h00 (Chung *et al.*, 2011; Costa *et al.*, 2014; Ganesan *et al.*, 2019; Garde *et al.*, 2019; Lin *et al.*, 2022). In some countries, night shifts for nurses may start between 21h00 and 03h00 (Chung *et al.*, 2011; Costa *et al.*, 2014; Karhula *et al.*, 2018; Lin, *et al.*, 2022; Shiffer *et al.*, 2018), ending between 06h00 and 09h00 (Chung *et al.*, 2011; Costa *et al.*, 2014; Shiffer *et al.*, 2018). In a review of European nurses (Garde *et al.*, 2019), and in studies on hospital nurses in America (James *et al.*, 2021; Petrov *et al.*, 2014; Rogers *et al.*, 2004; Wilson *et al.*, 2019), nurses working 12-hours start their day shifts and end their night shifts at 07h00. According to the Basic Employment Conditions Act (1997), night work in South Africa falls between 18h00 and 06h00, where hospital nursing shifts often start at

19h00 and end at 07h00 (Petrov *et al.,* 2014; Rogers *et al.*, 2004; Wilson *et al.*, 2019), opposite to the start and end times of day shift nurses (James *et al.*, 2021; Wilson *et al.*, 2019).

Although not in the context of nursing, later start times to shift from 06h00 to 07h00 have been found to improve sleep length and quality, and reduce sleepiness on shift (Rosa *et al.*, 1996), as this allows for an increase in sleep duration per time delay (for example shifts starting one hour earlier means sleeping for one more hour) (Costa, 2010). Knauth (1993) recommended that an early start to a morning shift should be avoided as it reduces the amount of time available for sleep prior to the duty period This is because early starts to morning shifts require workers to wake up earlier (Costa, 2010). With early starts that shifts, nurses to wake up earlier and sleep later to account for travel time, directly influencing the amount of time available for sleep (Halter & Sahu, 2015). Moreover, early wake times between 04h00 and 05h00 leads to increased sleepiness on duty for the day (Costa, 2010). On the other hand, later start time of morning shifts, means a later start time to night shifts and subsequent later onset times for sleep (Rosa *et al.*, 1996). A later end-time for night shifts, however, makes sleeping post shift difficult due to high levels of circadian-driven alertness levels in the day (Rosa *et al.*, 1996; Wickwire *et al.*, 2017), with nurses naturally secreting higher levels of cortisol at the end of a night shift in the presence of light stimulus (Copertaro *et al.*, 2011; Faraut *et al.,* 2022).Taking into consideration the evidence presented above, it is therefore recommended that early morning shift do not start earlier than 06h00, and that night shifts do not start after 23h00 (Ferguson & Dawson, 2012; Knauth, 1993; Knauth, 1996; Knauth & Hornberger 2003, Lerman *et al.*, 2012, Sallinen & Kecklund, 2010).

The above literature shows that there is no optimal way in which shifts can be arranged. Shifts that are arranged that promote the disruption of the natural circadian rhythms have various effects on sleep, alertness, and fatigue, thus shift systems that minimise circadian disruption are ideal. It is therefore imperative that employers follow guidelines and recommendations to limit the negative effects of shift work on sleep-wake behaviours. Together, shift work's contribution to the disruption sleep-wake behaviours, sleep disturbances and sleep quality left unattended are associated with greater levels of sleepiness and fatigue (Costa, 2010; Korompeli *et al.*, 2013). While

sleepiness and fatigue are inter-related and often used interchangeably (Shen *et al.,* 2006), fatigue is a separate concept also affected by shift work, discussed below..

2.8. UNDERSTANDING THE EFFECTS OF SHIFT WORK: FATIGUE

There is no clear, universal definition of fatigue due to its multi-faceted nature; however, fatigue can be identified as an unpleasant state of weariness, tiredness and/or exhaustion, and reduced motivation and energy in response to excessive demands, high workloads, increased stress exceeding the body's threshold, interfering with one's physical and/or mental resources and capacity to complete tasks, and ultimately performance (Aaronson *et al.*, 1999; Berger *et al.,* 1991; Chen *et al.,* 2014; Han *et al.*, 2014; Lee *et al.*, 1991; Lerman *et al.*, 2012; Ream & Richardson, 1997; Rogers, 2008; Samaha *et al.*, 2017). Occupational fatigue is described as a multifaceted general feeling of exhaustion exacerbated by high working demands in the absence of adequate recovery (Farag *et al.*, 2022).

The common symptoms of fatigue that have been identified are excessive sleepiness, irritability, headaches, fidgeting and inability to concentrate, and slower reflexes (Caldwell *et al.*, 2019; Gander *et al.*, 2019; Silva *et al.*, 2010). If acute in nature, fatigue can be alleviated through adequate sedentary rest/sleep, appropriate diet, and exercise (Aaronson *et al.*, 1999; Åkerstedt & Wright, 2009; Barker & Nussbaum, 2011; Caldwell *et al.*, 2019; Gander *et al.*, 2019; Gifkins *et al.*, 2020; Smith-Miller *et al.*, 2014; Techera *et al.*, 2016). However, if adequate rest cannot be achieved, acute fatigue can develop into chronic fatigue which is not typically alleviated through rest (Aaronson *et al.*, 1999; Åkerstedt & Wright, 2009; Caldwell *et al.*, 2019; Gander *et al.*, 2019; Gifkins *et al.*, 2020; Smith-Miller *et al.*, 2014; Techera *et al.*, 2016).

Occupational fatigue is described as a multifaceted general feeling of exhaustion exacerbated by high working demands in the absence of adequate recovery (Farag et al., 2022). Some studies that have used the Standard Shiftwork Index indicate that nurses working 12-hour shifts experience moderate chronic fatigue, with scores between 25 (Ruggerio, 2003; Korompeli *et al.*, 2014) and 27 (McElroy *et al.*, 2020). In other contexts, nurses in other contexts working permanent night shifts experience higher chronic fatigue with scores of 30 (McElroy *et al.*, 2020) to 32 (Saleh *et al.*, 2018) compared with day shift nurses' scores of 24 (Ferri *et al.*, 2016; McElroy *et al.*, 2020) and rotating shift nurses working nights with scores of 26 (Ferri *et al.*, 2016) to 33

(Saleh *et al.*, 2018). A review of studies investigating acute and chronic fatigue and inter-shift recovery using the Occupational Fatigue Exhaustion Recovery Scale (OFER) (Gifkins *et al*., 2020), show that nurses experience higher acute fatigue than chronic fatigue, with night shift nurses experiencing worse inter-shift fatigue (Geiger-Brown *et al.*, 2012).

Increased duration of shifts extending the wake period increases the risk of errors for nurses, and increased fatigue-related errors and impaired concentration, as well as work-related accidents and injuries (Dembe *et al.,* 2009, Geiger-Brown *et al.,* 2012). Night shift nurses are at a higher risk of incident and errors as their attention and alertness levels decrease considerably towards the end of a night shift, affecting reaction time and performance lapses (Geiger-Brown *et al.,* 2012; Seong *et al.,* 2021; Wilson *et al.,* 2019). Long shifts also have been found to increase the experience of stress which can further interfere with memory, attention, and the ability to perform complex cognitive tasks (Dembe *et al.,* 2009). In healthcare, workplace safety incidents are administrative, procedural, charting, transcription, and medication errors as well as associated higher incidences of sleep loss-related motor-vehicle accidents whilst commuting (Dembe *et al.,* 2009; Gold *et al.,* 1992; Smith Miller *et al.,* 2014). Motorcar accidents (after work hours) and job-related injuries are positively correlated with long shift hours and types of shift schedules (Dembe *et al.,* 2009). Shift work affecting sleep resulted in struggling to stay awake, exhaustion, and extreme drowsiness resulting in seven near-accidents within one month (Smith-Miller *et al.,* 2014); where drowsiness is highest after a third consecutive night shift (Martyn *et al.*, 2021). Another effect of sleep disturbances and fatigue because of shift work is the increased risk of needlestick incidences among nurses (Bagheri Hosseinebadi *et al.*, 2017; Imes *et al.,* 2023; Trinkoff *et al.*, 2007), which threatens the lives of nurses through hospital acquired infections.

Research into the mechanisms of fatigue have highlighted that considering sleep as the sole contributor to fatigue overlooks various predisposing, precipitating and perpetuating factors such as anxiety, depression, physical fitness and activity, substance abuse, noise and lighting, working environment, and job demands/workload and control (Caldwell *et al.*, 2019), which are also contributing factors to sleep-wake behaviours (Chaput *et al.*, 2018; Goel *et al.*, 2013).

Together, shift work affecting sleep and subsequent feelings of fatigue have a variety of implications for safety and wellbeing of nurses. While fatigue-related performance decrements have implications for the nursing process, health implications may further exacerbate negative experiences of chronic sleep loss and circadian misalignment associated with shift work (Rogers, 2008; Techera *et al*., 2016). How shift work affects health is briefly discussed below.

2.9. SHIFT WORK AND HEALTH

Shift work-related effects on sleep-wake behaviours and fatigue have been linked to disorders of metabolism, changes in hormone secretions and immune system functions (Chaput *et al.*, 2020; Grieger-Brown *et al.*, 2012; Sun *et al.*, 2019). Increased and excessive secretion of cortisol as a consequence of circadian stress (as previously explained) leads to fat and insulin disorders, further affecting visceral health of nurses (Korompeli *et al.*, 2014; Niu *et al.*, 2015; Rosa *et al.*, 2019).

Some studies have highlighted an association between night shift work (and associated circadian stress) and increased risk of developing gastrointestinal issues of heartburn, abdominal pain (Caruso *et al.,* 2004; Harringon, 2001; Knuttson & Bøggild, 2010), and obesity (Buchvold *et al*., 2015; Hirotsu *et al*., 2015). Nurses working permanent night shifts are at a higher risk of developing cardiovascular disorders than day shift nurses (Chung *et al*., 2009); where working more than two consecutive shifts have shown elevated heart rates/physiological stress (Chen *et al.*, 2014). Some cardiovascular disorders include hypertension, dyslipidaemia (Burdelak *et al.*, 2012; Kawachi *et al.*, 1995; Mosendane *et al.*, 2008) where the risk of heart palpitations are four to 10 times greater in nurses receiving poor quality sleep (Edéll-Gustafson, 2002).

Reports have shown shift work and alterations to the sleep-wake cycle affects reproductive function (Rosa *et al.*, 2019; Nurminen, 1998; Yuan *et al.*, 2011). Nurses under the age of 40 years-old working shifts have reported irregularities in menstrual cycles and an increased risk of adverse pregnancy outcomes (Rosa *et al.*, 2019; Yuan *et al.*, 2011). With the changes in various physiological and endocrine functions associated with circadian misalignment, shift work and night work are also associated with certain cancers (Harrington, 2001, Papantoniou *et al.*, 2015). Apart from these pathological associations mentioned above, some studies have also found a

relationship between shift work and musculoskeletal disorders of the neck, shoulder and back, because of the physical demands of nurses and limited time for recovery between shifts (Trinkoff *et al.*, 2006; Zhang *et al.*, 2018).

As stated before, there is no optimal shift system design and each system has varying effects on health, performance and well-being. Variations in the effects of shift work, however, are also dependent on inter-individual variability among workers. Mediating factors such as work experience, age, gender, chronotype, lifestyle need to be taken into careful consideration when understanding and managing the effects of shift systems (Costa *et al.*, 2014; Knauth 1993).

2.10. MEDIATORS OF SHIFT WORK

2.10.1. Shift work experience

It has been suggested that years of service or shift work experience is a mediating factor to changes in sleep-wake behaviours and fatigue (Chung *et al.*, 2007) where nurses who have worked less than one-year experience disturbances to their sleep and those who have worked shifts for more than five years are able to tolerate shifts better. In contrast, it has been found that nurses who have worked for more than 18 years have greater disturbances to their sleep on night shifts and days off than those who have worked for less than 10 years (Korompeli *et al.*, 2013), while experience of shift work had no difference at all (Saksvik-Lehouillier *et al.*, 2012). In contrast, a lack of change in sleep-wake behaviours among night shift nurses has been observed and attributed to shift work tolerance and choosing to work night shift (Barton, 1994), and the ability to develop various behaviours and skills to deal with the complexity and workload of working shifts over time (Åkerstedt & Wright 2009; Korompeli *et al.*, 2014; Zion *et al.*, 2018).

2.10.2. Age

Previous research on sleep quality among nurses suggests that sleep quality decreases from the age of 30 years (Hajaghazadeh *et al.*, 2019; Marquié & Foret, 1999; Saksvik *et al.*, 2011), where senior nurses experience less sleepiness on night shift (Zion *et al.*, 2018). Contrastingly some studies found no changes in the quality and duration of sleep in older nurses, suggesting that sleep quality did not diminish with age among female nurses (Chung *et al*., 2007; Kunzweiler *et al.*, 2016; Zion *et al.*, 2018). Older shift workers have been found to adapt better to rapidly forward

rotating shift systems compared with their younger counterparts (Saksvik *et al.*, 2011), while younger adults tend to experience greater sleepiness than older healthy adults (Dorrian *et al.*, 2011; Duffy *et al.*, 2009). Older shift workers have been found to be able to maintain performance better after sleep deprivation (Duffy *et al.*, 2009). This has been explained through older adults requiring less sleep than younger adults for daily functioning (Duffy *et al.,* 2009, Hirshkowitz *et al.*, 2015; Paruthi *et al.*, 2016). The "healthy shift worker effect" might explain the tolerance to shift work in the older and more experienced workers (Saksvik *et al.*, 2011).

2.10.3. Gender

The nursing profession is predominantly staffed with women who often have greater domestic and social responsibilities, such as caring for children and elder dependents (Carayon & Gurses, 2008; Johnson *et al*., 2014; Han *et al.*, 2014; Korompeli *et al.*, 2013; Korompeli *et al.*, 2014; Palhares *et al*., 2014; Winwood *et al*., 2006). Studies show that dealing with the combination of the work and domestic environments are stressful for female nurses, especially when having to work shifts and care for dependents (Klopper *et al.*, 2012; Korompeli *et al*., 2013; Shiffer *et al.*, 2018; Wilson, 2002). It is suggested that female nurses in comparison with their male counterparts experience greater sleep disturbances (Åkerstedt *et al.*, 2002; Korompeli *et al.*, 2013; Korompeli *et al.*, 2014; Marquié, & Foret, 1999, Saksvik *et al.*, 2011), with approximately a third of female nurses experiencing poorer sleep quality, greater sleep onset latency and shorter sleep duration (Kunzweiler *et al.*, 2016; Saksvik *et al.*, 2011). Kunzweiler and colleagues (2016) however found no significant differences in the sleep quality related to gender differences. It has been suggested that nurses who are married or living with a partner experience greater sleep disturbances and poorer sleep quality (Haldar & Sahu, 2015; Korompeli *et al.*, 2013; Korompeli *et al.*, 2014; Marquié, & Foret, 1999), especially nurses with chronic diseases (Korompeli *et al.*, 2014). Greater sleep disturbances observed amongst female nurses have also been associated with disturbed menstrual and reproductive processes (Chung *et al*., 2013; López-Soto *et al.*, 2019).

2.10.4. Chronotype

Chronotype, or morningness-eveningness preference, is the phenotypic expression of the circadian phases (Goel *et al.*, 2013) and has become one of the most important factors to consider when scheduling shift work and predicting shift-related sleep-wake

behaviours (Chung *et al.*, 2007; James *et al.*, 2020; Rathore *et al*., 2012). When there is a mismatch between individual chronotype and the shift that is worked, this is referred to “social jetlag” (Argent *et al*., 2015; Wittmann *et al*., 2006).

Research suggests that chronotype differs between gender, and changes with age (Carrier *et al*., 1997; Hittle & Gillespie, 2018). Studies using the Morningness-Eveningness Questionnaire (MEQ) and other subjective activity preference questionnaires suggest that children present as morning types, having earlier sleep and wake times, showing a phase delay in adolescents and young adults towards evening preference of later sleep and wake times (Carskadon *et al*., 1993; Fischer *et al*., 2017; Lee *et al*., 2011), and reverting back to morning type as one gets older due to hormonal and lifestyle factors (Carrier *et al.*, 1997; Fischer *et al.*, 2017; Lee *et al.*, 2011).

Previous research has found that nurses tend to be an intermediate chronotype (Hajaghazadeh *et al.*, 2019; Hittle & Gillespie, 2018; Saleh *et al.*, 2018), and that nurses with an evening preference tend to choose to work permanent night shifts (Karhula *et al.*, 2018). In addition, those who present as morning types tend to have more household dependents that need looking after, for example children or the elderly (López-Soto *et al*., 2019). In a review by López-Soto and colleagues (2019), morningness was associated with less daytime sleepiness and better sleep quality among nurses. Evening types are said to tolerate the effects of night shifts better than other chronotypes by having a greater propensity for adaption (Papatoniou *et al.,* 2015; Saksvik *et al.,* 2011). In contrast, some studies found that evening types experience greater daytime sleepiness and poorer sleep quality, associated with higher feelings of fatigue, (Hajaghazadeh *et al.*, 2019; Jung & Lee, 2015, Yazdi *et al.,* 2014). When age is accounted for, older morning-types and younger evening-types were found to experience greater sleepiness on night shifts (Zion *et al.*, 2018).

2.10.5. Lifestyle factors

2.10.5.1. Work-life balance

A significant challenge faced by shift workers is balancing the demands between home and work. Previous research has highlighted that females who choose to work night shifts are able to plan and match their schedules with their domestic responsibilities and children’s activities, resulting in less sleepiness and good sleep quality (Zion *et*

al., 2018), while one study found no differences in sleep quality in female nurses with or without children (Edéll-Gustafsson, 2002). Another aspect of work-life balance is travelling to and from work. Nurses who have longer commuting times tend to wake up earlier and sleep later, directly influencing the amount of time available for sleep (Haldar & Sahu, 2015).

In a study by West and colleagues (2016), nurses expressed that working night shifts enables them to reduce the costs associated with childcare by relying on spouses to care for children at night and being able to care for dependents during the day. Some studies argue that younger shift workers in healthcare often have fewer children and associated responsibilities contributing to their overall recovery and complain less of sleep disturbances attributed to higher shift work tolerance (Korsiak *et al*., 2017; Saksvik *et al*., 2011). In contrast, nurses working nights complain about missing out on social and home life, often leading to conflict (West *et al.*, 2016). In some cases, younger nurses and nurses who are not married are less likely to have to take care of dependents (Geiger-Brown, *et al.*, 2012) and thus have a greater tolerance to shift work and less disturbances to their sleep (Korsiak *et al*., 2017; Saksvik *et al*., 2011).

Research into changes in sleep-wake behaviours have identified certain substances used by shift workers (Dorrian *et al.*, 2011; Dorrian *et al.*, 2017). Alcohol and sleeping aids/hypnotics have been used to initiate and maintain sleep (Dorrian *et al*., 2017; Sun *et al.*, 2019). Coping mechanisms such as alcohol and hypnotics seem to be used less among older and more experienced shift workers (Agostini *et al*., 2022).

2.10.5.2. Alcohol consumption

In some instance, alcohol has been used to induce sleep in shift workers (Dorrian *et al*., 2017; Sun *et al.*, 2019), with one in three nurses consuming alcohol to aid sleep onset, and alcohol consumption is greater among younger workers and males (Dorrian *et al.*, 2011; Dorrian *et al.*, 2017). In one study, those working 12-hour rotating shifts tended to consume alcohol more than those working 8-hour rotating shifts (Dorrian *et al.*, 2017). While alcohol consumption may induce sleep, it negatively affects sleep quality and quality (Dorrian *et al*., 2017) however in one study, there were no significant differences between sleep history and alcohol consumption (Hittle *et al*., 2020). In another study, alcohol consumption to induce sleep impaired attention and performance on the following day among nurses (Sun *et al.*, 2019).

2.10.5.3. Sleeping pills

Nurses, more so night shift nurses, have been found to use sleeping aids or hypnotics more on duty days than on off-duty days, especially after consecutive shifts (Dorrian *et al.*, 2011; Futema *et al.*, 2015; Martyn *et al.*, 2021). Nurses often takemore than one type of sleeping pill in order to fall asleep (Futema *et al.*, 2015). The use of sleeping pills has been associated with a lower quality of life and greater feelings of depression (Martyn *et al.*, 2021).

2.11. SUMMARY AND STUDY RATIONALE

The impact of shift work sleep-wake behaviours and fatigue in the context of nursing have been extensively explored, with greater concerns around extended shifts, night work, and rotating shift schedules being clearly outlined in previous literature as a risk to patient and staff safety and wellbeing. While shift work has a direct impact on sleep and fatigue, there are also individual factors that have an indirect or mediating effect. Although there are policies in place to limit the number of hours and consecutive shifts worked, and to allow for rest periods between shifts, the impact of shift systems on sleep-wake behaviours and fatigue among nurses in South Africa is poorly understood, if at all among nurses in private healthcare. Since the length of shifts are typically 12-hours compared with other private healthcare sectors globally, little is known about how shift arrangements are scheduled in private healthcare facilities. Furthermore, to the researcher's knowledge, based on meetings with the stakeholders, the rotating shift system is not scheduled like a typical 2/3 shift system. It is therefore important to consider the shift systems worked by nurses in the private South African Healthcare system, and to determine the severity of shift-work related changes in sleep, using the Standard Shiftwork Index.

CHAPTER III:
METHODOLOGY

3.1. RESEARCH DESIGN

This study adopted a cross-sectional survey design, using a positivist paradigm and quantitative approach (Terreblanche *et al*., 2006), to characterise the shift system and shift scheduling characteristics adopted in three health care facilities and the subsequent impact of these shift characteristics on nurses' perceptions regarding the shift arrangements and reported sleep/wake behaviours and self-reported fatigue. The study was comprised of two phases. Phase one was a pilot and phase two was the main data collection explained in more detail below.

3.2. DATA COLLECTION INSTRUMENT

3.2.1. Overview of Standard Shiftwork Index

This study made use of the Standard Shiftwork Index (SSI), which is a battery of self-reported questionnaires to assess shift-work related problems on the premise that shift workers experiences disturbances in sleep and biological rhythms, and family and social life (Barton *et al.*, 1995; Korompeli *et al.*, 2013). The SSI was developed to measure the extent to which different shift systems affect large groups of shift workers, namely nurses, midwives, and industrial and service workers (Barton *et al.*, 1995). The questionnaire is separated into three broad categories: outcomes, modifiers, and general information. Outcomes relate to problems experienced by shift workers, modifiers relate to differences between shift workers that might moderate the impact of shift work, and general information refers to worker shift systems, work contexts and biographical information (Barton *et al.*, 1995). The full SSI explores the effects of shift work on sleep characteristics, feelings of fatigue, general physical and mental health, family and social life, personality and neuroticism, job satisfaction, and coping methods (Barton *et al.*, 1995). The full SSI is extensive and consists of six sections of roughly 200 items. For completeness, these sections are summarised below. The full SSI can be accessed on the Working Time Society's website, http://www.workingtime.org/technical.

Section 1 - "Your General Biographical Information" includes questions regarding age, gender, domestic life and experience of shifts (Barton *et al.*, 1995).

Section 2: “Your Sleep and Fatigue” consists of the Sleep Quality and Disturbance Questionnaire and Chronic Fatigue Scale (Barton *et al.*, 1995).

Section 3 - “Your Health and Well-being” consists of the Physical Health and General Health Questionnaires, the Cognitive-Somatic Anxiety Questionnaire, Eysenck Personality Questionnaire (Barton *et al.*, 1995).

Section 4 – “Your Social and Domestic Situation” interrogates disruptions to social and domestic life due to working shifts through the Social and Domestic Survey (Barton *et al.*, 1995).

Section 5 – “Coping with Shiftwork” Questionnaire gathers information around how shift workers cope with shift work (Barton *et al.*, 1995). This questionnaire consists of two sub-scales of four items each: engagement and disengagement where coping strategies for disruption to sleep, social and domestic life, and work are rated on a Likert scale (Barton *et al.*, 1995).

Section 6 – “The Type of Person you are” explores differences in individual differences and personality factors that may influence or moderate the effects of shift work (Barton *et al.*, 1995). This section includes the Composite Morningness Questionnaire which provides insights into the preferences, in terms of time of day, for daily activities (morning or evening). The scale is scored on a Likert scale where a higher score indicates morning preferences while lower scores are indicative of evening preferences (Barton *et al.*, 1995). The Circadian Type Inventory is used to identify flexibility of sleeping habits and the ability to overcome drowsiness scored on a Likert scale (where higher scores indicate greater flexibility and languidity) (Barton *et al.*, 1995). Lastly, the Eysenck Personality Inventory included in section six measures the degree of extraversion on a Likert-scale, where a higher score indicates greater extraversion (Barton *et al.*, 1995). Tucker and Knowles (2008) argued that the different sections of the SSI can be used independently (Ferri, Guadi, Marcheselli, Balduzzi, Magani, & Di Lorenzo, 2016).

In this study, only three sections of the SSI were used to fulfil the aims and objectives of determining the impact of shift work on sleep-wake behaviours and fatigue, which can be found in the google form: https://docs.google.com/forms/d/1_QfJbPdUA7JNobnC42uI3xVzfzivkzmkpKr6fYT7M-U/edit. The first section was

split into two sections separating the biographical information and shift details. The sections of the SSI that were included in this study were as follows (appendix D & E).

3.2.2. Section 1: Your general biographical information

This section was designed to explore general information on how individuals' circumstances moderate the impact of shift work. Nurses were required to answer questions pertaining to their age, gender, experience in the profession and experience of shift work, and domestic situation – questions relating to their spouse/partner and their working time, number of persons in a household and household dependents that need looking after, overtime hours, moonlighting and career breaks (Barton *et al.*, 1995). Nurses reported on the sequencing, timing, and duration of shifts, the frequency and organisation of night work, the regularity of shift schedules, and the degree of flexibility within the shift system. This section characterised the nurses' domestic situation and their shift systems.

3.2.3. Section 2: Your shift details

This section was designed to explore and contextualise the shift system. Nurses were required to answer questions pertaining to shift characteristics of the sequencing, timing, and duration of shift (start and end times), and how the shifts are arranged (successive shifts, maximum number of shifts, successive days off, what other shift follows the shift the nurses work, night shift organisation, weekends off per 28 days). Nurses also answered questions pertaining to control over the shift system and the start and end times of shifts, and rostering. Included in this section were questions around commuting times, mode of transport to the various shifts, physical and mental workload, as well as time pressure and emotional stress, reasons for working shifts as well as the advantages and disadvantages of the nurses' shift system.

3.2.4. Section 3: Your sleep

3.2.4.1. Sleep quality and disturbance

Section 3 of the SSI explored how shift work impacts on nurses' sleep and fatigue. Sleep disturbance was measured using the Sleep Quality and Disturbance Questionnaire (Barton *et al.*, 1995). This scale has two parts consisting of 11 items scored on a Likert scale. The first section includes timing and duration of sleep taken before and between different shifts and days off; and the timing and frequency of naps

on different shift and days off (Barton *et al.*, 1995). The second section explored information regarding the quality and difficulties of sleep experienced on different shifts and days off. In accordance with the original SSI document and the SSI Manual, items 2.1-2.3 and 2.11 are coded appropriately, 2.4 – 2.6 are reverse coded, and 2.9-2.10 are coded independently and do not form part of the scale. For a total sleep disturbance score, all responses are added together, where a higher score indicates higher sleep disturbances with a total score of 120. A sleep disturbance score per shift type is summed separately per shift, where a higher score indicates greater sleep disturbances, with a total score of 30 per shift/days off (Barton *et al.*, 1995).

3.2.4.2. Chronic fatigue

Chronic fatigue was measured using the Standard Shiftwork Index Chronic Fatigue scale (SSICFS). This scale consists of 10 items regarding feelings of vigour, energy, and tiredness and/ or lack of energy and an optional comment section (Barton *et al.*, 1995). With reference to the original SSI document, items a, c, e, g, l are reverse coded. All Likert-scale responses are summed to give one total score. Possible scores range from 10 to 50, where a higher score indicates higher feelings of chronic fatigue (Barton *et al.*, 1995).

3.2.5. Section 4: The type of person you are

3.2.5.1. Composite morningness-eveningness questionnaire

This section of the SSI obtains information on individual preferences for daily habits, feelings, behaviours, and actions (such as wake and sleep onset preferences and how this informs individual activity levels at different times of the day), using the Composite Morningness/Eveningness Questionnaire (26 items) presented as four/five alternate responses per question, and scored using a Likert scale. Chronotype may influence how nurses respond to different types of shift work, and therefore it is important to identify and understand for nurses' future shift schedule implementation (Hittle & Gillespie, 2018). With reference to the original SSI document, items c, d, e and k are reverse coded. All Likert scale responses are summed to give a total chronotype score, where evening type corresponds to a score of 22 and less, intermediate types are scored between 23-43, and morning types score 44 and above (Barton *et al.*, 1995).

3.2.5. Reliability and Validity

The SSI is valid and reliable to use on the South African nursing population. The SSI has been used extensively in the global transport and healthcare industries, both in cross-sectional and longitudinal studies (Centofanti *et al.*, 2018; Courtney, Francis, & Paxton, 2013; Ferri *et al.*, 2016; Korompeli *et al.*, 2013; Korompeli *et al.*, 2014), as well as among the South African population by Visser (1999).

3.2.6. Research Hypothesis

The research hypothesis is applicable to the quantitative component only regarding the effect of shift work on sleep-wake behaviours and fatigue. The dependent variable for the first hypothesis was identified as the changes in sleep/wake behaviours for example the sleep disturbance score and chronic fatigue score. The independent variable was identified as the type of shift system in which the nurses work. μ1 = permanent night shift; μ2 = rotating shift; μ3= permanent day shift.

H_0 = there is no difference between the type of shift system worked and changes in sleep/wake behaviours and fatigue/fatigue=like symptoms; where μ1 = μ2 = μ3.

H_1 = there is a difference between the type of shift system worked and the changes in sleep/wale behaviours and fatigue/fatigue-like symptoms; μ1 ≠ μ2 ≠ μ3.

The dependent variable for the second hypothesis was identified as levels of fatigue/fatigue-like symptoms, for example the chronic fatigue score. The independent variable was identified as the type of shift system in which the nurses work.

H_0 = there is no difference between the type of shift system worked and fatigue/fatigue=like symptoms; where μ1 = μ2 = μ3.

H_1 = there is a difference between the type of shift system worked and fatigue/fatigue-like symptoms; μ1 ≠ μ2 ≠ μ3.

3.3. STUDY SETTING

Three private healthcare facilities, located in East London, in the Eastern Cape province of South Africa, were selected as study sites (see Figure 2 that follows). They consisted of a hospital (healthcare facility A), rehabilitation centre (healthcare facility B) and a psychiatric clinic (healthcare facility C). The hospital consisted of four intensive care units, general and cardiac theatre (including a Cath Lab-theatre specialised to conduct cardiac procedures), an emergency unit, and six wards. The psychiatric clinic consisted of 28 wards and neuro-clinic. The rehabilitation centre was divided into two units further divided into smaller wards that house between one to four patients.

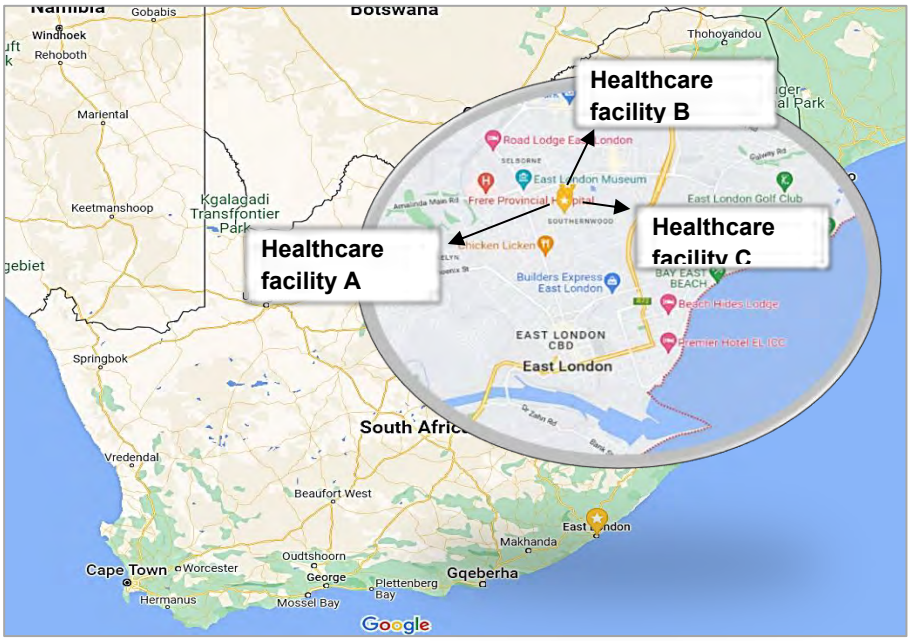

Figure 2: Locations of the three healthcare facilities

(taken from google maps*:* https://www.google.com/maps/place/East+London/@-32.9553222,27.5004012,10z/data=!3m1!4b1!4m6!3m5!1s0x1e66e6fc26098303:0x62b7d874cc1a1b9f!8m2!3d-33.0198434!4d27.903905!16zL20vMDF0anFw)

3.4. ETHICAL CONSIDERATIONS

Before the commencement of the pilot study and phase 2 of data collection, ethical clearance was granted by the Rhodes University Human Ethics Committee (Ref: 2021-5040-6245, Appendix A) as well as the gatekeeper (Ref: 29092021/4, Appendix B). As per the private healthcare institution's ethical clearance, the facilities will not be mentioned by name, but are referred to as "Healthcare facility A", "Healthcare facility B", and "Healthcare facility C".

3.5. RESEARCH SAMPLE

Participants were recruited from within the three selected private healthcare facilities and considered as stakeholders. The focus population of this study were nurses employed by the selected private healthcare facilities, including agency staff, who were working any types of shifts and registered with the South African Nursing Council (SANC). Participants were required to be nurses registered with SANC and work shifts.

3.6. RECRUITMENT AND SAMPLING METHODS

The sampling techniques used for this study involved a combination of convenience, purposive and snowball sampling (Terreblanche *et al.*, 2006). Nurses were recruited via email with the aid of nursing and unit managers, taking into consideration the COVID-19 pandemic and associated risks with contact information sessions. Participants were also recruited through word of mouth and advertisements/ recruitment posters (Appendix C) placed within the workplace (see Appendix F) for both the pilot and main data collection.

Using Slovin's sample size formula consisting of a 95% confidence interval, 5% margin of error, and approximately 300 nurses as a proposed maximum sample, the minimum number of nurses required to participate was 169. However, the number of participants was determined by the number of nurses who were willing to participate and complete the questionnaire.

3.7. PROCEDURE

3.7.1. Pre-study preparations – Initial meetings with the stakeholders

(All email communications could not be included in this study to protect the anonymity of the gatekeeper and its employees)

On 2 June 2021, the researcher contacted the nursing manager via email to determine the interest of the gatekeeper in participating in the study, the different shift arrangements worked by nurses across the three facilities, and to further discuss the aims and objectives via Zoom. Meetings were held via Zoom until 28 November 2021 to mitigate any risk of COVID-19 transmissions. On 29 November 2021, after ethical clearance was granted by both Rhodes University and the private healthcare facilities, an in-person meeting was held between the researchers, the nursing managers of the three facilities and the hospital manager to discuss the usability, validity and reliability

of the questionnaire and proposed pilot study and to provide all the necessary documents (ethical clearance letters, recruitment posters, and the SSI questionnaire). During this discussion it was agreed that most nurses would not have access to complete the questionnaire online, and that both online and physical copies would have to be administered to the nurses.

The researcher was responsible for ensuring participants had a complete understanding of the purpose of the methods of the study and the requirements for participation (Jones, 2000). Therefore, the purpose of the study and what was required of the participants was clearly described on the cover letter of the questionnaires and during all information sessions held during the data collection period. It was emphasised that participation was voluntary, and that if nurses chose to withdraw, they were able to do so without negative consequences. Nurses were also informed that by completing the questionnaire, they had consented to the study without disclosing personal particulars by ticking the check box of the consent clause found on the cover letter. This ensured anonymity and protection of personal information (POPIA, 2013).

3.7.2. Pilot study (Appendix E)

Prior to the start of the main data collection, a pilot study was conducted. The aim of the pilot study was to explore the utility and reliability of the SSI in the nurses' work context, prior to canvassing participation from the rest of the nursing staff. During this phase, and considering the COVID-19 pandemic, the researcher explored the methods through which the SSI could have be completed (Google forms and hard copy), which further enabled additional adaptations post-pilot completion. Question descriptions were designed and provided to support the participants when completing the questionnaire.

On 1 December 2021 a formal information session was held with the nursing and unit managers. A small group of nurses were purposively sampled with the assistance of the nursing and unit managers from the three selected private healthcare facilities. Of the 12 completed questionnaires, four came from the two smaller healthcare facilities, and eight questionnaires were from the main healthcare facility.

The pilot study provided insight on how to approach data collection, given the unlikelihood of contact sessions and the challenges associated with the current pandemic. The pilot study also aided with gaining insight into the employed nurses'

current knowledge surrounding shift work and its impact on their health, safety and performance as well as the usability of the questionnaire. Nurses wrote comments on the questionnnaire about the stability next to specific questions. After receiving sufficient completed pilot questionnaires on 13 December 2021, more information or descriptions were added to questions to aid participants' understanding of the questions and support their answering based on the comments written on the completed pilot questionnaires. In light of the suggestions, some additional descriptions were added to the SSI used in this study and included the following:

- indicating work hours in hours and minutes and range estimates (e.g. 12-24 hours),
- added to the description around shifts was that12-hour day shifts that start at 06h00 or 07h00 should be considered as "early morning" shifts as per the question,
- in the description for the mode of transport used, "group hired or paid transport is considered public transport and not a combination of public and private transport," was added
- added in the description around successive shifts, "successive shifts are shifts that are worked one after the other with no days in between",
- added to the description for mental workload, "mental workload is not emotional workload or stress. Mental workload refers to attention and mental resources needed for completing tasks",
- "Emotional stress refers to psychological strain and uneasiness triggered by a perceived threat in daily life, "was added to the description for emotional stress.

3.7.3. Main data collection (Appendix F)

All relevant nursing managers were contacted on 15 December 2021 with an invitation to participate in the study and a recruitment poster was disseminated to nurses via email. On 21 December 2021, unit and nursing managers were informed of the postponement of data collection into the new year due to the increase in COVID-19 infection rates. The researcher contacted the nursing managers on 12 January 2022 for approval to commence data collection, and all relevant nursing and unit managers were contacted again on 17 January 2022 for the commencement of the data collection.

Nurses, through a combination of convenience, purposive and snowball sampling, in the three healthcare facilities, were invited to participate by completing the SSI either online or as a hard copy. The researcher met with the nurses and unit managers informally at the beginning of the testing period in each ward's nursing station (in person), during which the aims and objectives of the study, as well as what was required of the nurses, were outlined. This ensured that any questions nurses had pertaining to the survey were answered prior to completing the study. Due to issues of technology availability for the nurses, no online information sessions were held.

Data collection spanned two months, in which participants were regularly reminded to complete in their own time as not to interfere with work during the shift. Due to nurses' issues of technology and internet availability, the researcher emailed unit managers and nurses weekly/bi-weekly to remind nurses to complete the questionnaire as well as informally visiting all wards in the three facilities once a week on handover days/shift changes. After noticing the slow completion rate of the questionnaires, the researcher contacted the nursing managers between 26-31 January 2022 for permission to host 20-minute sessions with the nurses on weekends (in consideration of nurses' workloads during the week) to aid nurses in completing the questionnaires.

Towards the end of data collection, the researcher emailed the relevant parties to remind them of the final stages of data collection on 17 February 2022, followed by a final email concluding data collection on 28 February 2022.

Completed hard copy questionnaires were deposited in sealed boxes placed in each ward of the bigger healthcare facility, and one common area in each of the other two smaller healthcare facilities. Three soft copy questionnaires were completed, while the other 48 completed questionnaires were hard copy.

3.8. STATISTICAL ANALYSIS

3.8.1. Data reduction

At the end of the data collection period, the raw data from both the Google forms and hard copy questionnaires were cleaned and coded (Appendix F) in a Microsoft Excel document. Likert scale data were given codes ranging from one to four/five/six based on the number of responses available per question (Appendix F). Data regarding "Not applicable"/ "n/a" and "0" responses were excluded from the analysis and left as missing data, except in the case of household dependents that needed looking after.

In instances that nurses gave responses that were in a numerical range (e.g., 10-15) responses were averaged (e.g., 12.5) on the reduced data sheet. If there was a time range (e.g., 22h00-23h00), the time was averaged and converted to a numerical value (e.g., 22.5). All data regarding amount of time (e.g., 20 minutes) was converted to hours (e.g,. 0.4); and data on experience (e.g., 5 years and 6 months) was displayed in years (e.g., 5.5) for ease of interpretation. Incomplete answers pertaining to sleep disturbance, chronic fatigue and morningness-eveningness were excluded if complete scores could not be summed appropriately. Too few or no nurses worked afternoon, half-day, or other shifts, therefore they were also excluded from the study.

A total of 51 nurses completed the questionnaire, of which 20 reported working permanent night shift (19h00-07h00), 13 reported working rotating shifts, and 18 worked permanent day shifts (07h00-19h00). This was established after cross referencing with questions such as: “how many night shifts do you work per year?” and “how are your shifts organised?”. This is relevant to state here given that the emergence of these different shift types influenced the nature of the statistical tests that were applied. Considering that nurses working rotating shifts worked at the same times as permanent day and permanent night shifts, without a proper indication of the speed and direction of the rotation, the total sleep disturbance score was calculated as follows: (sleep disturbance score (day) + sleep disturbance score (night))/2 + sleep disturbance score (days off).

3.8.2. Normality testing

A statistical analysis of the reduced data was performed using TIBCO Statistica® (version 14.0.0.15) and Microsoft Excel 365. The Shapiro Wilk and Kolmogorov-Smirnov tests were used to test normality. Most variables were not normally distributed with the exceptions of “do you feel unsafe traveling to other shifts”, “number of successive afternoon shifts”, “number of successive other shifts”, “maximum number of shifts before days off in the past month” and “choose end time for other shifts”. Some variables computed for sleep disturbance scores (day shift – how rested do you feel between day shifts?, and on days off?, how do you normally sleep between days off?), and the composite morningness/eveningness score were normally distributed. Too few nurses reported working afternoon, half day and other shifts to make a meaningful comparison between those shifts, and therefore information in this regard was not included in the results section of this study.

3.8.3. Descriptive statistics

For the data that was normally distributed descriptive statistics in terms of means (*M*) and standard deviations (±SD) were for napping and the composite moningness-eveningness global score. For data that was not normally distributed, medians (*Mdn*) and interquartile ranges (*IQR*) of 25% and 75% were used for the rest of the data for ease of interpretation before performing inferential statistics.

3.8.4. Inferential statistics for the general sample

The analyses of the data occurred in two distinct phases. Initially, the data for the overall sample was analysed. For this, the Kruskal Wallis test was used at a 95% confidence interval (Appendix G) to compare any differences in the basic demographic data, shift characteristics and nurses' other background information (experience, partner, and commuting) and the impact that the different types of shifts (day, night and days off) had on sleep wake behaviour, sleep disturbances and chronic fatigue The Kruskal-Wallis was used only when comparisons could be made between variables applicable to the general sample. Following the Kruskal-Wallis test, after significant differences were found between groups, a Multiple Comparisons test was conducted as a post hoc test to determine where the significant differences were between the three different groups of shift nurses.

The second phase of data analysis focused on comparing the different shift types that emerged (permanent night, permanent day and rotating shifts). Given that not all groups worked night shifts (as in permanent day shifts workers) and not all groups worked day shifts (as in permanent night shifts) a Mann-Whitney U test was used to make comparisons between shift groups working the same type of shift (permanent day vs rotating day; permanent night vs rotating night) against variables relating to the different shifts worked. Where comparisons could be made between all three, the Kruskal Wallis test was applied.

3.8.5. Thematic analysis

From the SSI, the qualitative question explored the advantages and disadvantages of nurses shift systems. A thematic analysis was used to describe these advantages and disadvantages of the nurses shift systems (Braun & Clarke, 2012). In accordance with the framework by Braun and Clarke (2012), the researcher became familiar with the data set and generated initial codes, within the codes searched for obvious themes. These themes were further reviewed, defined and named, and finally presented in a

thematic map created using an online mind mapping software called Miro (https://www.miro.com) and saved as JPEG image files.

3.8.5.1. Overview of the phases by Braun and Clarke (2006)

The first step of the thematic analysis requires familiarising with the data by reading through the qualitative answers repeatedly, while taking notes, to identify outstanding patterns. The second step generates initial codes based on the patterns identified in step one, in which the researcher used colours identifying the meaningful phrases or words. Step three required the researcher to group answers based on the colour codes prescribed to identify the broader themes present in the data set. These groups generated main themes and sub-themes when appropriate. The fourth step required reviewing the themes identified in step three to distinguish boundaries between themes and sub-themes. In this step the researcher also refined themes by grouping similar themes and removing irrelevant or isolated patterns, while continuing to review the themes for any missing codes left out in previous steps. The fifth step in the thematic analysis process involved defining and naming the themes and sub-themes identified in step four appropriately, where the researcher was able to narrate the qualitative findings in line with the interests of the study. The final thematic analysis was presented as two separate mind maps for the advantages and disadvantages of nurses' shift systems, displayed in the results section. In terms of reflexivity, the researcher had prior knowledge of the fatigue and sleepiness felt by nurses by working in the same hospital albeit in the administration division, as well as having a family member working in the hospital as a nurse. Thus, the researcher acknowledges the preconceived notions based on experience and from the literature about the sleep and fatigue felt by the nurses in the sample. During informal walkabouts, nurses would voice certain aspects of their work that resonated with the literature and themes generated from the advantages and disadvantages of their shifts in the SSI. While this may have influenced how the data were analysed thematically, the researcher took steps to limit the bias that these insights may have created. Firstly, The researcher became familiar with the data before using codes, and shared the coded data with the main supervisor (who was removed from situations) during the thematic analysis for review. The researcher then used an inductive approach to generate the themes, and revised the themes presented in chapter three against the literature. In addition, responses for advantages and disadvantages of the shift system were similar, limiting bias of the researcher when generating and interpreting the themes.

CHAPTER IV

RESULTS

Out of the 300 nurses employed between the three healthcare facilities, 51 questionnaires were completed, with a response rate of 17%.

In the first section of demographic data and shift characteristics, information related to the general sample will be reported first, followed by demographic data and shift characteristics of nurses working different shift arrangements (permanent night, permanent day and rotating shifts). This section is followed by background information including nurses' working experiences, partner information and commuting, including a thematic analysis on the advantages and disadvantages of nurses' shift systems. Thirdly, sleep-wake behaviours including the sleep duration, sleep disturbances (of the general sample, and then nurses of different shift arrangements), naps taken and use of sleeping aids will be reported, followed by workload, chronic fatigue and morningness-eveningness preferences (each reporting for the general sample first followed by the different shift arrangements).

Significant differences and a 0.05 confidence level are presented in the tables either as a bold red Asterix (*****) or alphabetical letter (**a**). The number of responses per variable were indicated in bold "**N (%)"**. If the variable had subsequent Reponses, for example Likert scale data, the frequency of the subsequent responses was calculated as a percentage of the main variable. For example, there were 51 (100) responses for marital status, where 25 (49.02) responded "married or living with a partner".

4.1. BASIC DEMOGRAPHIC DATA AND SHIFT CHARACTERISTICS

4.1.1. General sample

With reference to the demographic data of the general sample in Table 1, the median age of the sample was 44.2 (*IQR* 35 to 54) with most nurses being female (90.2%). Most nurses were above 46+ years of age (*n* = 21; 42%) and reported being married/living with a partner (*n* = 25; 49.02%); while 41.18% (*n* = 21) of nurses were single. In terms of household dependents, there was a greater number (*n* =74; 44.58%) of adult dependents in the age range (25-60). Altogether there were 175 household dependents. Thirty-nine (38.29%) dependents needed to be looked after by *n*=31 (60.78%) nurses, with a median of 2 (*IQR* 1 to 2) dependents per household.

Table 1: Basic demographic data obtained from the nurses of all three private healthcare facilities.

Variables	N (%)	*Mdn* (IQR 25-75%)
Age	**50 (98.04)**	**44.2 (35-54)**
≤35	14 (28)	
36-45	15 (30)	
46+	21 (42)	
Sex	**51 (100)**	
Male	5 (9.80)	
Female	46 (90.2)	
Marital status	**51 (100)**	
Married/partner	25 (49.02)	
Separated/divorced	3 (5.88)	
Single	21 (41.18)	
Widowed	2 (3.92)	
Household dependents (categories in years)	**51 (100)**	
Total dependents	166	
0-5	23 (13.86)	
6-12	25 (15.06)	
13-18	19 (11.45)	
19-24	14 (8.43)	
25-60	74 (44.58)	
60+	11 (6.63)	
No. of household dependents that need looking after (responses)	**31(60.78)**	
Total dependents need looking after	39 (100)	
0	8 (25.81)	
1-2	24 (77.42)	
≥3	7(22.58)	

With reference to the shift characteristics of the general sample in Table 2, nurses reported that their shift arrangements were mostly regular (*n* = 40; 80%). Nurses working day shifts reported having approximately up to five consecutive shifts with two or three consecutive days off. Nurses working night shift work reported a median of seven consecutive shifts (*IQR* 5.5 to 7) followed by five to seven consecutive days off. All nurses reported having a median of two (*IQR* 2 to2) weekends off per 28 days. Most nurses reported working a median of 42 (*IQR* 40 to 50) hours excluding overtime and a median of 12 (*IQR* 0.29 to 12) hours of paid overtime per week, while only *n* = 16 (31.37%) nurses worked a median of two (*IQR* 1.63 to 7.26) hours of unpaid overtime per week. Nurses were given a median of two (*IQR*1 - 2) weeks' notice of roster where only one nurse reported being given only one hour's notice.

Table 2: Shift characteristics (successive shifts and off days, shift organisation, regularity, perceptions of scheduling, and changes in shift scheduling of nurses across the three facilities

Variables	N (%)	*Mdn* (IQR 25-75%)
Shift regularity	**50 (98.04)**	
Regular	40 (80)	
Irregular	4 (8)	
Flexible	6 (12)	
Shift Type		
Permanent night	20 (39.22)	
Rotating	13 (25.49)	
Permanent Day	18 (35.3)	
Number of successive shifts		
Day	31 (60.78)	3 (2.5-5)
Night	27 (52.94)	7 (5.5-7)
Total number of successive shifts before day(s) off	34 (66.67)	5 (2.5-7)
Maximum number of shifts before days off	22 (43.14)	5 (3-7)
Average number of successive days off	47 (92.16)	2.5 (2-6)
Average nights worked in a year	19 (37.25)	165 (91.25-174)
Weekends off / 28days	47 (92.16)	2 (2-2)
Shift cycle **(in weeks)**	34 (66.67)	3.5 (1-4)
Notice of roster **(in weeks)**	37 (72.55)	2 (1-2)
Average weekly working hours **excluding overtime**	49 (96.08)	42 (40-50)
Average working hours of **paid overtime per week**	38 (74.51)	12 (0.29-12)
Average working hours of **unpaid overtime per week**	16 (31.37)	2 (1.63-7.26)

4.1.2. Demographic information across the different shift arrangements

With respect to demographic variables displayed in Table 3 below, more permanent night (*n* = 8; 42.11%) and day shift nurses (*n* =8, 44.44%) are 46+ years of age, with more rotating nurses being 36 years or older. The majority of nurses across the three shifts arrangements were female, where permanent night nurses are mostly single (*n*=13; 65%) and rotating (*n* = 7; 53.85) and day shift nurses (*n* = 12; 66.67) were mostly married or living with a partner. Across the three shifts, the majority of nurses' household dependents fall within the 25-60 year-old age range. Permanent night nurses reported having more dependents between the ages of 0-18 compared with rotating and day shift nurses. More permanent night staff had dependents that needed looking after, with most nurses across all different shift types needing to look after one or two dependents per household, but this was not compared using statistics.

Table 3: Basic demographic data per shift obtained from the nurses of all three private healthcare facilities

	Permanent night		Rotating		Permanent Day	
Variables	**N (%)**	***Mdn* (IQR 25-75%)**	**N(%)**	***Mdn* (IQR 25-75%)**	**N (%)**	***Mdn* (IQR 25-75%)**
Age	**19 (90.48)**	**40 (35-58)**	**13 (100)**	**43 (36-49)**	**18 (100)**	**43.5 (35-53)**
≤35	6 (31.58)		3 (23,08)		5 (27.78)	
36-45	5 (26.32)		5 (38.46)		5 (27.78)	
46+	8 (42.11)		5 (38.46)		8 (44.44)	
Sex	**20 (100)**		**13 (100)**		**18 (100)**	
Male	1 (5)		3 (23.08)		1 (5.56)	
Female	18 (95)		10 (76.92)		17 (94.44)	
Marital status	**20 (100)**		**13 (100)**		**18 (100)**	
Married/partner	6 (30)		7 (53.85)		12 (66.67)	
Separated/divorced	1 (5)		1 (7.69)		1 (5.56)	
Single	13 (65)		4 (30.77)		4 (22.22)	
Widowed	0		1 (7.69)		1 (5.56)	
Household dependents (categories in years)						
Total dependents	80		34		46	
0-5	10 (12.5)		5 (14.71)		8 (17.39)	
6-12	9 (11.25)		8 (23.53)		3 (6.52)	
13-18	11 (13.75)		5 (13.71)		3 (6.52)	
19-24	8 (10)		3 (8.82)		2 (4.35)	
25-60	35 (43.75)		13 (38.24		26 (56.52)	
60+	7 (8.75)		0		4 (8.7)	
No. of household dependents that need looking after (responses)	**19 (90.48)**		**9 (69.23)**		**15 (83.33)**	
Total dependents need looking after	33 (18.86)		19 (10.86)		15 (8.57)	
0	4 (12.12)		0		8 (53.33)	
1-2	13 (39.39)		6 (31.58)		5 (33.33)	
≥3	2 (6.06)		3 (15.79)		2 (13.33)	

With reference to the shift characteristics in Table 4, nurses across the three facilities reported having a regular shift system, with few permanent and rotating nurses reporting irregular and flexible shift systems. Day shift nurses, however, reported only having a regular shift system. Permanent night shift nurses had a significantly higher total of successive shifts before days off compared with rotating (***H* (2) = 10.67, *p* = 0.048***) and permanent day nurses (***H* (2) = 10.67, *p* = 0.02***). Similarly, while there were no significant differences between groups, permanent night nurses had a higher maximum number of shifts before days off than both rotating and day shift nurses.

Table 4: Shift characteristics (successive shifts and off days, shift organisation, regularity, perceptions of scheduling, and changes in shift scheduling of permanent night, rotating and day shift nurses across the three facilities

	Permanent night		Rotating		Permanent Day	
Variables	**N (%)**	**Mdn (IQR 25-75%)**	**N (%)**	**Mdn (IQR 25-75%)**	**N (%)**	**Mdn (IQR 25-75%)**
Shift regularity	**20 (100)**		**13 (100)**		**17 (94.44)**	
Regular	14 (70)		9 (69.23)		17 (100)	
Irregular	4 (20)		2 (15.38)		0	
Flexible	2 (10)		2 (15.38)		0	
Number of successive shifts						
Day			11 (84.62)	2.5 (2-3)	15 (83.33)	3(2.5-5)
Night	17 (85)	7 (7-7)	7 (53.85)	7 (4-7)		
Total number of successive shifts before day(s) off	11 (55)	7 (5.5-7) *	10(76.92)	2.75 (2-5) *	13 (72.22)	3(2.5-5)
Maximum number of shifts before days off	6 (30)	7 (4-7)	10(76.92)	5(2-10)	6 (33.33)	4.5 (3-9)
Average number of successive days off	18 (90)	7 (2.5-7)***	12 (92.31)	2.5(2-3)	17 (94.44	2 (2-2.5)***
Average nights worked in a year	13 (65)	168 (164-174)	4 (30.77)	125.63 (91.25-171.5)	2(11.11)	
Weekends off / 28days	20 (100)	2 (2-2)	11 (84.62)	2 (2-4)	16 (88.89)	2 (2-2.5)
Shift cycle **(w)**	13 (65)	1 (1-4)	9 (69.23)	4 (3-4)	12(66.67)	3 (2-4)
Notice of roster **(w)**	16 (80)	2 (1-2)	9 (69.23)	2(1-2)	12(66.67)	2 (1-2.5)
Average weekly working hours **excluding overtime**	20(100)	46.25 (41-84)	12 (92.31)	40.5 (40-42)	17 (94.44)	41 (42-44)
Average working hours of **paid overtime per week**	17 (85)	12 (0-16)	8 (61.54)	12 (0.15-30)	13 (72.22)	10 (2-12)
Average working hours of **unpaid overtime per week**	3 (15)	7 (1-18)	4 (30.77)	4.75 (1.75-9.75)	9 (50)	2 (1.75-2)

In terms of days off, permanent night nurses had significantly more “average number of successive days off” than permanent day nurses ***H* (2) = 10.83, *p* = 0.004*****, with rotating and day shift nurses having a similar number of days off with no significant differences. Permanent night and rotating nurses worked a median of 168 (*IQR* 164 to 174 nights) and a median of 125.63 (*IQR* 91.25 to 171.5 nights) nights per year respectively. In Table 5 above, all shift nurses reported having median of two weekends off per 28 days, and two weeks’ notice of their roster. Rotating shift nurses reported a longer shift cycle than permanent and day shift nurses, however there was no significance. Rotating and day shift nurses had more similar average weekly working hours, with permanent night nurses working more weekly hours *Md* = 46.25 (*IQR* 41 to 84 hours), however weekly hours was not significant between groups.

With no significant differences found between groups for paid overtime, permanent night and rotating nurses worked similar overtime hours per week, with permanent day nurses working slightly less overtime. Permanent night nurses worked more unpaid overtime hours than rotating and permanent day shift nurses weekly, with no significant differences observed between shift arrangements.

4.2. PERCEPTIONS AROUND SHIFTS AND ROSTERING

This section of results shows the nurses' perceptions of control around rostering and explores the reasons nurses have chosen their shift systems. Nurses also reported on the advantages and disadvantages of their shift systems.

4.2.1. Timing of shifts

With reference to the timing of shifts in Table 5, nurses working day shifts are satisfied with the start time of their morning shift; however, they preferred to end day shifts at 16h00 instead of at 19h00. Nurses working night shifts (permanent and rotating) were also satisfied with the start and end times for night shifts.

Table 5: Actual and preferred shift start and end times for nurses working across the three private healthcare facilities.

Variables	**Actual**		**Preferred**	
Shift Type	**N (%)**	***Mdn* (IQR 25-75%)**	**N (%)**	***Mdn* (IQR 25-75%)**
Day				
Start	40 (78.43)	07h00 (06h45-07h00)	34 (66.67)	07h00 (07h00-08h0)
End	38 (74.51)	19h00 (13h00–19h00)	28 (54.9)	16h00 (13h45-18h00)
Night				
Start	32 (62.75)	19h00 (18h53-19h00)	31 (60.78)	19h00 (18h30 – 19h00)
End	32 (62.75)	07h00 (07h00-07h00)	33 (64.71)	07h00 (06h00-08h00)

4.2.2. Perceptions of control

With respect to nurses' perceived control over the shift system as illustrated in Figure 3, some nurses (n=8) felt that they had no control (n=16.33%), more (n=12) reported having "not very much" control over their shift system (24.49%), with less (n=10) reporting "a fair amount of control" (20.41%), quite a lot of control (n=7; 14.29%), and complete control (n=12; 24.49%) over their shift system. Similarly, 38.78% of nurses (n=19) felt that they had no control over the start and end times of their shifts, while others felt they did not have very much control (n=7; 14.29%), a fair amount (n=6; 12.24%), quite a lot (n=10; 20.41), or complete control (n=7; 14.29%)

over the start and end times of shifts. When comparing perceptions of control across the different groups of shift nurses, there were no significant differences observed.

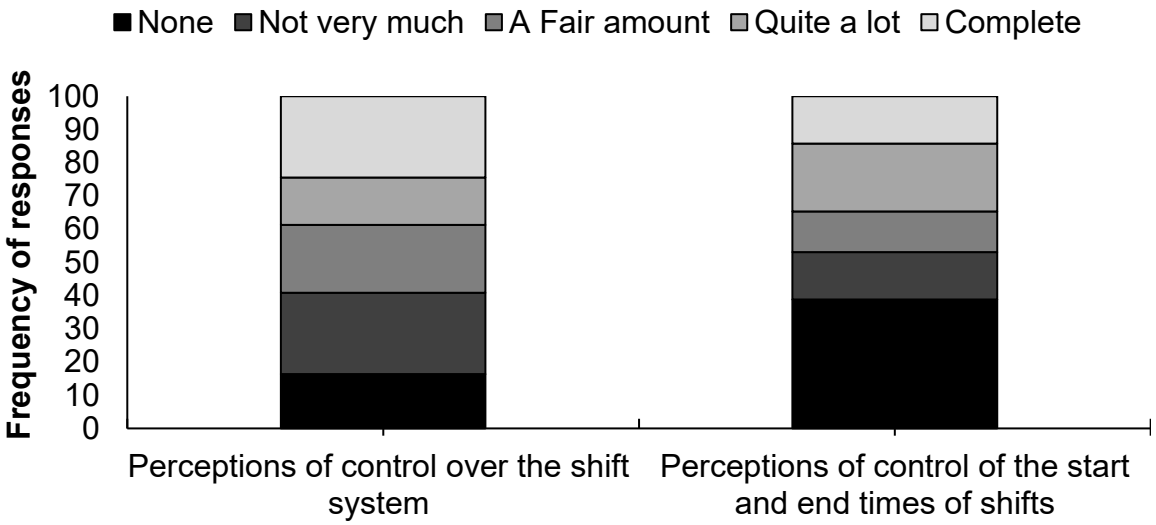

Figure 3: Likert scale responses regarding nurses' perceptions of control of the shift system (n = 49) and control over start and end times of shifts (n = 49)

4.2.3. Rostering

With reference to the changes in rostering shown in Figure 4, more nurses reported "almost never" having to change their roster on short notice (n = 17; 36.96%), with 53.95% of responses between "almost never" and "rarely". When asked how often nurses are required to swop shift with colleagues, 52.18% of nurses responses fell between "sometimes" and "frequently, with more nurses responding "sometimes" having to swop shifts with colleagues (n = 22; 47.83%). More nurses responded "sometimes" requesting to work specific shifts (n = 23; 51.11%), with 60% of responses between "sometimes" and "frequently".

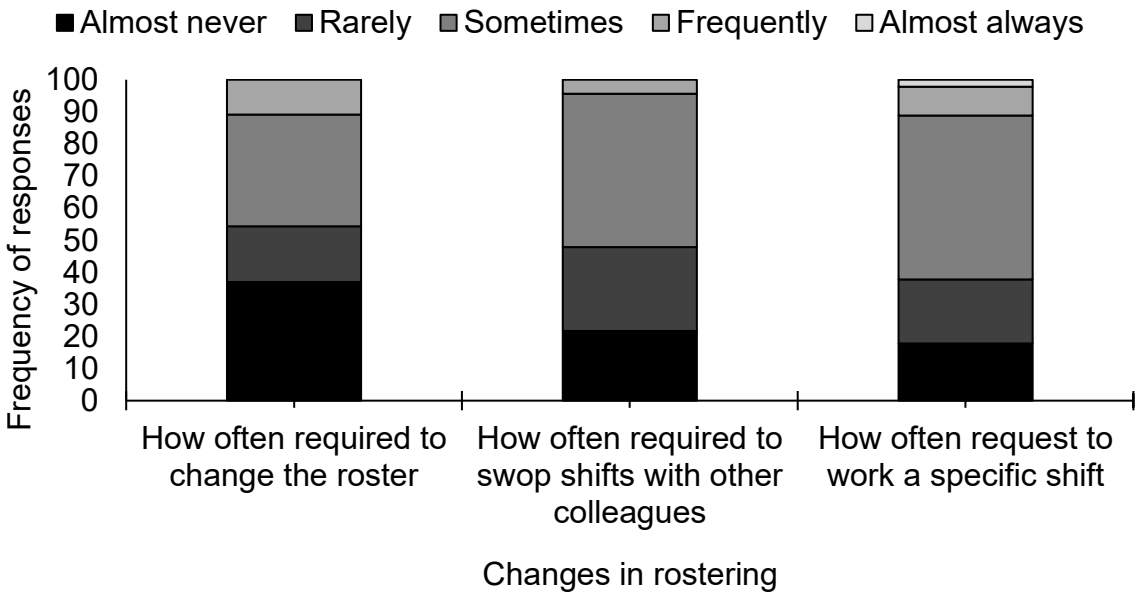

Figure 4: Changes in rostering for nurses across the three private facilities (how often nurses are required to change the roster (*n* = 48; 94.12%); how often nurses are required to swop shifts with other colleagues (*n* = 48; 94.12%); how often nurses request to work specific shifts (*n* = 47; 92.16%)

With reference to nurses changing their rosters on short notice in Figure 5, rotating nurses had to change their roster on short notice significantly more than permanent night ***H* (2) = 9.32, *p* = 0.02*** and day shift ***H* (2) = 9.32, *p* = 0.045**** nurses.

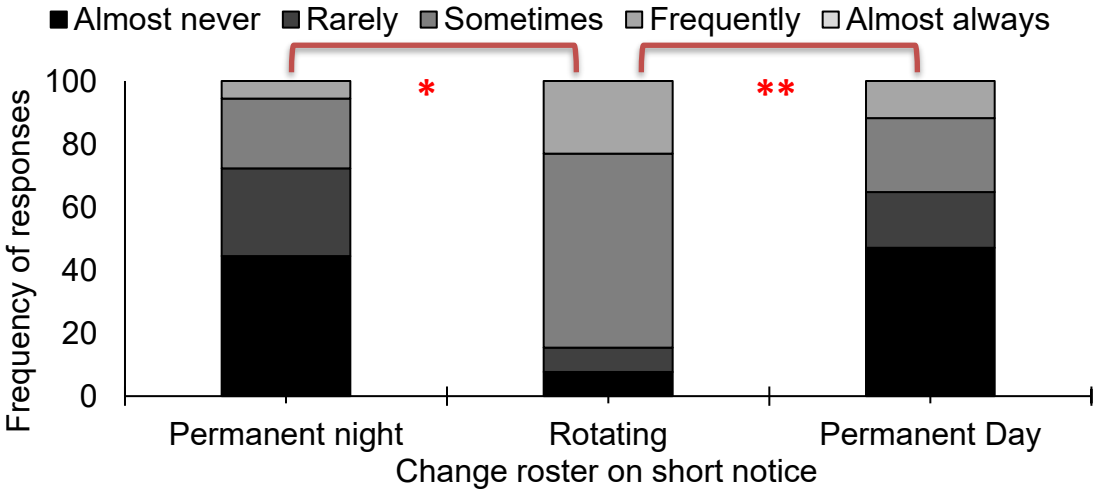

Figure 5: Changes in rostering on short notice for permanent (*n* = 18; 90%), rotating (*n* = 13; 100%) and day shift (*n* = 17; 94%) nurses across the three private facilities

Regarding nurses' ability to work a specific shift in Figure 6, it was found that rotating nurses were more likely to be able to request to work specific shifts than day shift

nurses ***H* (2) =6.997, *p* = 0.046***, showing that rotating nurses have slightly more flexibility in their shift systems. No significant differences were found between permanent night and day shift nurses.

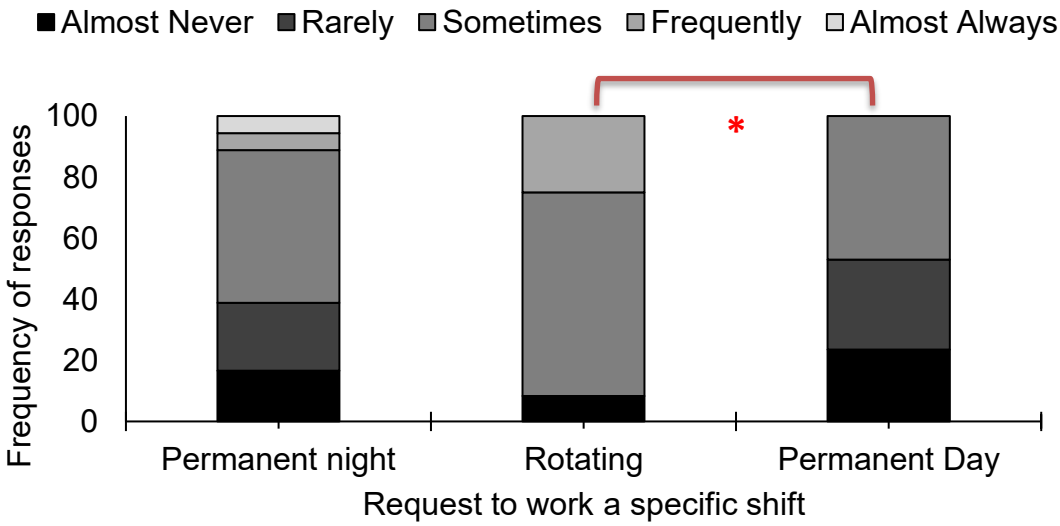

Figure 6: Requests to work a specific shift for permanent (*n* = 18; 90%), rotating (*n* = 12; 92.31%) and day shift (*n* = 17; 94.44%) nurses across the three private facilities

With reference to nurses' main reasons working shifts (see Figure 7), some nurses reported (very much a reason for me) that shifts were part of the job (*n* = 12; 34.29%) while more nurses reported that it was convenient for domestic responsibilities (*n* = 15; 42.86%). When asked about other reasons for working shifts, nurses reported having more quality time, working five days is exhausting and restrictive.

With reference to the main reasons for working shifts and when answering "other", most answers related to "part of the job", and "convenient for my domestic responsibilities". Other responses (*n* = 8*;* 15.69%) related to having days off (*n* = 3; 37.5%), quality time (*n* = 1; 12.5%), and rest (*n* = 3; 37.5%).

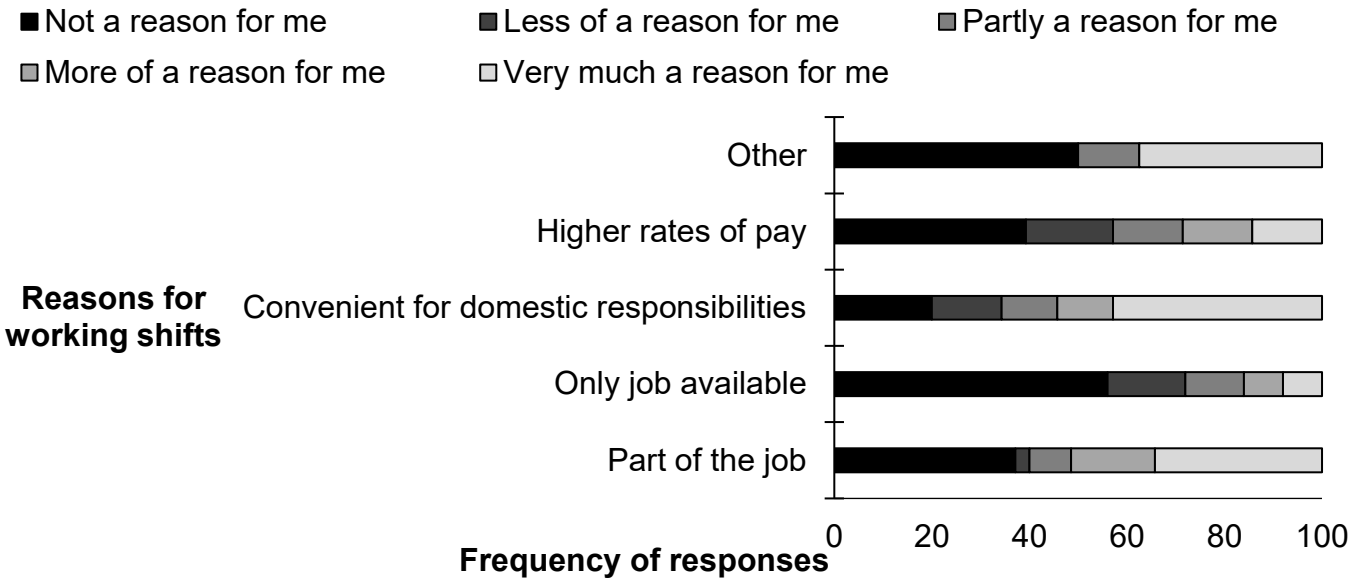

Figure 7: Main reasons why nurses work shifts across the three healthcare facilities (part of the job (*n* = 35; 68.63%); only job available (*n* = 25; 49.02%); convenient for domestic responsibilities (*n* = 35; 68.63%); higher rates of pay (*n* =28; 54.90%); other (*n* = 8; 15.69%).

4.2.4 Thematic analysis of the advantages of the shift system

Four main themes were identified for the advantages of the nurses shift system in Figure 8. The first, main theme was domestic life containing three sub-themes of quality time, family responsibilities and domestic responsibilities. The remaining three main themes were remuneration, sleep-wake behaviours, and leisure days/days off.

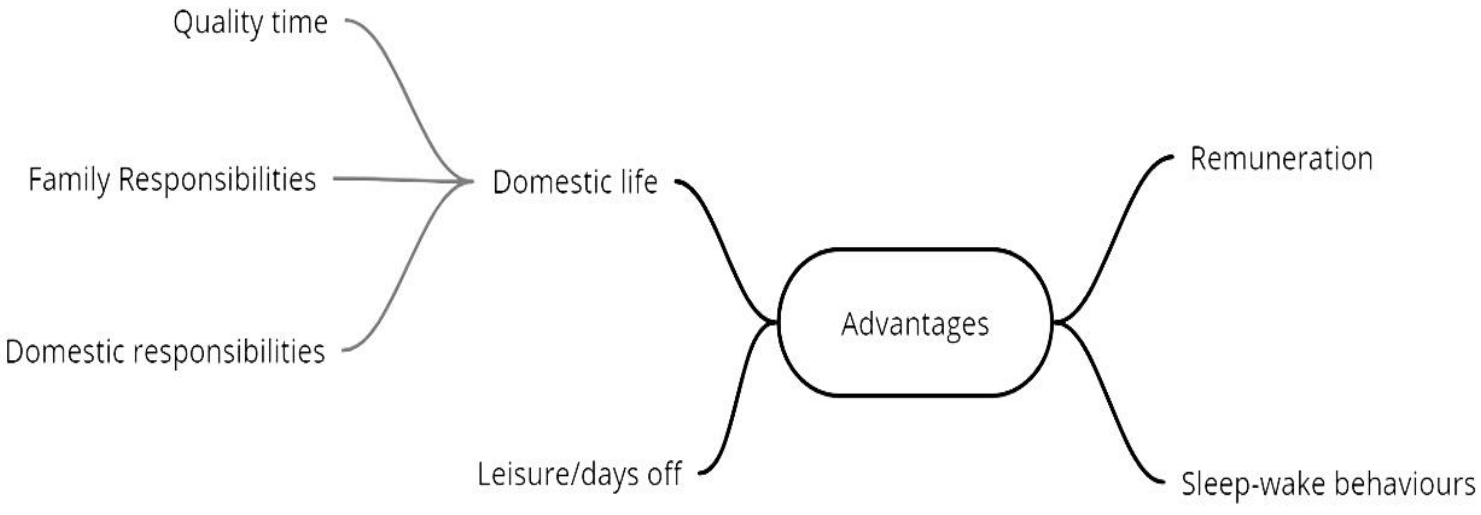

Figure 8: Nurses' perceived advantages of their shift system

4.2.4.1. Main theme 1: Domestic Life

Domestic life refers to any information regarding the intricacies of nurses' home life affected by their shift system

4.2.4.1.1. Sub-theme: Quality time

For subtheme quality time, nurses (especially permanent night nurses) found that working their shift system gave them more time off to spend with family. One nurse commented that there were "*regular hours for planning after hours with family";* another said, *"to be with my family most of the time especially on my seven nights off",* and others stated, *"going to visit family",* and *"hours with husband".*

4.2.4.1.2. Sub-theme: Family responsibilities

For this sub-theme "family responsibilities, the predictability of the shifts enabled nurses to tend to the needs of the family as captured by two participants who said that they are: *"able to take care for my children for school,"* and *"my child is left alone at night.,"*

4.2.4.1.3. Sub-theme: Domestic responsibilities

For this sub-theme, nurses reported being able to plan and make arrangements around their shift systems. Some examples include: *" You can sort of arrange things according to your shifts";* and *"Convenience for domestic responsibilities", "do housework".*

4.2.4.2. Main theme 2: Remuneration

A second emergent thematic advantage was that nurses who work night shifts noted that night-time allowance or the increased pay associated with working nights compared with working day shift was an advantage of their shift system. One nurse stated that there is a *"special night allowance";* and another said that *"payment rate is more during night shifts".*

4.2.4.3. Main Theme 3: Sleep-wake behaviours

The third advantage, which more permanent night nurses reported most, was that they were able to receive an adequate amount of sleep during the day, and that there was enough time to recover on their seven days off compared with the other shift nurses. One nurse said, *"you get to rest on your day off";* and another said, *"enough time to recharge after seven nights on".*

4.2.4.4. Main theme 4: Leisure/ Days off

Nurses in their specific shift schedules found that having off days in the week or weekends or having seven days off in the case of permanent night staff, was an advantage. Some excerpts include: *"if you work Saturday you get a day off the next week";* and *"7days off";* and *"days off during the week".*

4.2.5. Thematic analysis of the disadvantages of nurses' shift systems

Five main themes were identified for the disadvantages of nurses' shift systems as illustrated in Figure 9. These included: domestic life, which had sub-themes of family and personal and social responsibilities; sleep/wake behaviours had sub-themes of inadequate sleep and sleepiness. Fatigue had one sub-theme of workload, and other themes were shift organisation, leisure/off days, and organisational factors.

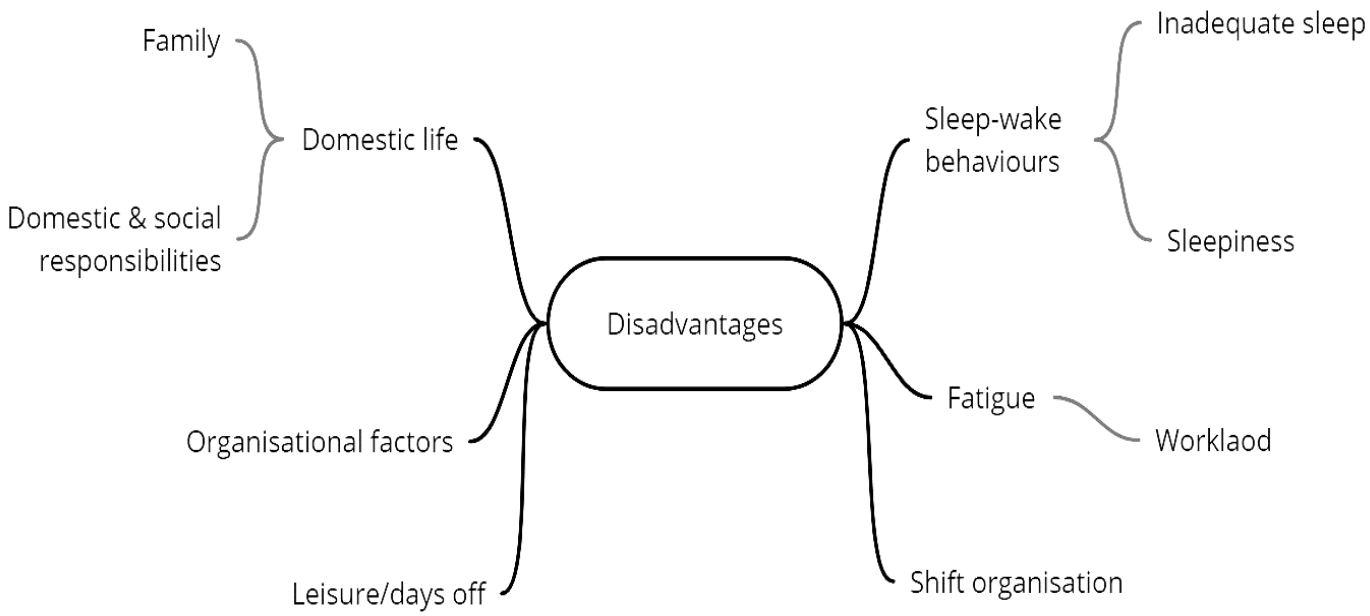

Figure 9: Nurses' perceived disadvantages of their shift system using an open-ended question in the SSI.

4.4.2.1. Main theme 1: Domestic Life

The main theme of domestic life refers to any information regarding family and any domestic and social responsibilities at home interfered by shift work.

4.4.2.1.1. Sub-theme: Family

Nurses, in the first theme of domestic life: family, felt that they had limited time to spend with and care for family, especially permanent night nurses working seven days on. Some examples include: "*missing my grandchildren before they go to school"; "don't have time to be with family".*

4.4.2.1.2. Sub-theme: Personal and social responsibilities

Another subtheme that emerged is that nurses, especially permanent night nurses found it difficult to tend to their domestic and personal responsibilities such as: *"disturb doing things during the day"; "working straight shift limited time to do household chores"; "interferes with social life, friends", and "have to take time off for appointments".*

4.4.2.2. Main theme: Sleep-wake behaviours

The main theme of sleep wake behaviours included responses from nurses regarding the amount of sleep and quality of sleep or rest that they were obtaining and experiences of sleepiness.

4.4.2.2.1. Sub-theme: Inadequate sleep

Rotating and day shift nurses reported having less issues achieving adequate sleep, whereas permanent night nurses said that they had difficulties falling asleep, especially in the day. One nurse said: *"not being able to sleep during the day as it becomes too hot at times and too noisy".* Another nurse stated that they were *"not getting enough time to sleep during the day, always tired (body and mind)"*. This contrasts with the theme of sleep displayed in the advantages of nurses' shift system, indicating that nurses' experience of shift work and sleep are individually specific.

4.4.2.2.2. Sub-theme: Sleepiness

An emergent sub-theme identified in the disadvantages of the shift systems was that nurses were tired and sleepy on duty. One nurse said: *"Some staff members are falling asleep while on duty"* while another nurse reported, "*Being exhausted at work."*

4.4.2.3. Main theme 3: Fatigue

The main theme of fatigue includes responses from nurses regarding the feeling of both physical and mental exhaustion and the levels of workloads experienced by the nurses.

4.4.2.3.1. Sub-theme: Workload

An emergent sub-theme of fatigue identified as a disadvantage was that nurses complained of heavy workloads. One nurse stated that working shifts was *"hectic".* Another nurse said that they were *"working under pressure";* with others saying *"sometimes its very heavy to do 12 hour shift"* and *"… after 21h00 in long cases can be very tiring and strenuous sometimes".*

4.4.2.4. Main theme 4: Shift organisation

The fourth theme identified as a disadvantage was that nurses often work long and unpredictable hours due to sudden changes in rostering, a shortage of staff, and having to be awake for longer periods of time due to long hours on duty. According to one nurse, her shift ended: *"sometimes after 21h00 in long cases."* Another nurse said that *"shift starts and ends before the shift time and after shift has ended, very long hours to stand".* One nurse complained that *"you may be told the day before that your shift for the next day has changed, and if you had arrangements you have to cancel on short notice. If you have a personal crisis you have to find someone to change shifts with and colleagues aren't always willing to help you."*

4.4.2.5. Main theme 5: Leisure/days off

Nurses, more so rotating shift nurses, complained that they did not have enough off days in between shifts, and that working public holidays and weekends was a disadvantage of their shift system. Some reports include: *"as much as I don't work too long before I get day off, my days off are short"; "working weekends having to work public holidays"; "no days off in-between".*

4.4.2.6. Main theme 6: Organisational factors

The last theme identified as a disadvantage to nurses' shift systems, was that because of a shortage of staff, rostering of duties hindered nurses' abilities to tend to personal responsibilities. Nurses also identified discourtesy in the workplace, as well as not appreciating colleagues falling asleep on duty. One nurse said that other nurses are: *"not respecting each other, talk behind back to each other".* Another nurse stated that there was a *"shortage of staff at night".*

4.2.6. Additional perceptions of the advantages and disadvantages

Regarding nurses' perceptions around the advantages and disadvantages of working shifts and whether or not to work a day job instead, illustrated in Figure 10, more

nurses reported that they would “probably not” quit working shifts to work a day-time job (*n* = 14; 30.43%), and that “maybe” the advantages of their shift system outweigh the disadvantages (*n* = 13; 28.26%).

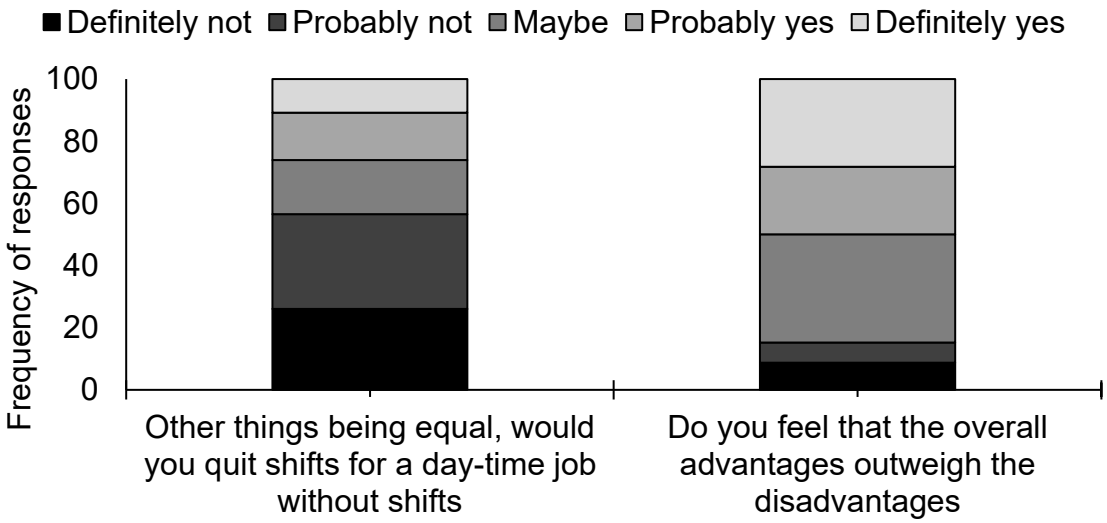

Figure 10: Nurses’ perceptions on choosing to work a day-time job without shifts (*n* = 46; 90.2%), and weighting of advantages and disadvantages of their shift system across the three healthcare facilities (*n* = 46; 90.2%)

With reference to nurses’ choice to quit working shifts to work day-time jobs without shifts, permanent night shift nurses were least likely to give up working shifts (*Md* = 2, n=20) compared with day shift nurses (*Md* = 3; n = 15), **H (2)= 12.46, p = 0.0018.**

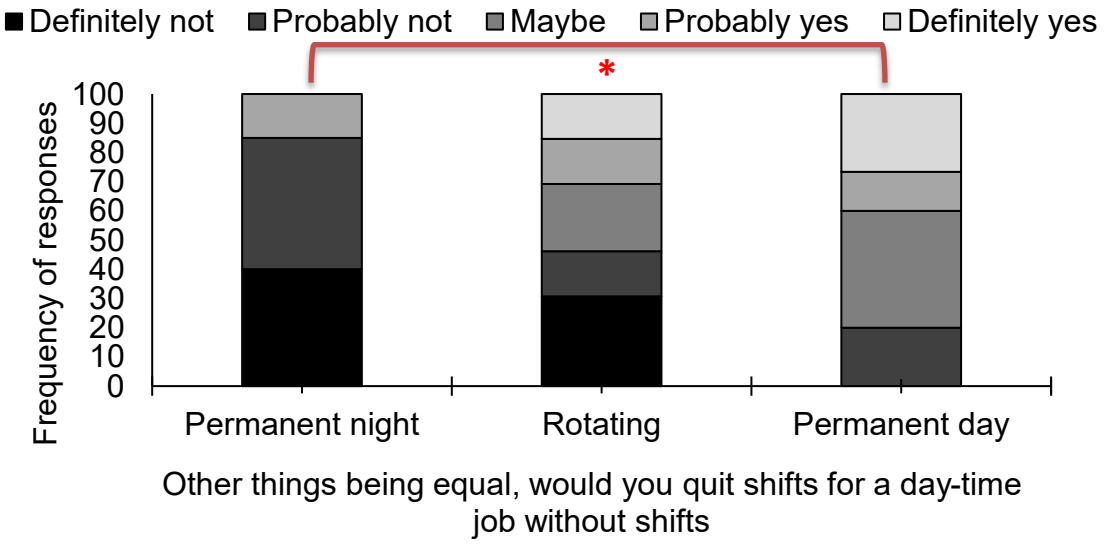

Figure 11: Nurses working different shift arrangements’ choice to quit working shifts to work a day-time job

4.3. WORK EXPERIENCE, PARTNER, AND COMMUTING INFOMRATION

This section displays results pertaining to nurse's professional experience working as a nurse, working in the current shift system, and working shifts overall, moonlighting, career breaks; partners' work hours, job schedule, and perceptions of nursing partner working shifts, as well as information around commuting.

4.3.1. Nurses' professional experience

With reference to nurses' professional experience in Table 6, no significant differences were found for all variables displayed. Most of the nurses in the general sample are registered professional nurses (n=36; 70.59%) having worked in their shift system for a median of 15 years (*IQR 8 years to 29 years*). Nurses in the general sample have been working in their present system for a median of 4 years (*IQR 1 year to 9 years*) and working shifts altogether for a median of 11 years and 3 months (*IQR 6 year and 3 months to 21 years*). In the general sample, most nurses (n=42; 84.31) did not work a second paid job and took a career break for a median of four months (*IQR 0 years to 1 year*).

Between the different shift arrangements, no significant differences were found for any of the variables displayed in table that follows. Rotating shift nurses have been working as nurses the longest with a median of 20 years (*IQR 7 years to 23 years*) with permanent night nurses working the least for 10 years and six months (*IQR 6 years and 6 months to 35 years*). While not significant, permanent day shift nurses have worked in their present shift system for a median of 6 years (*IQR 2 years to 13 years*), longer than rotating nurses working for a median of 5 years (*IQR 1 year to 10 years*) and permanent night nurses who have been working for a median of 1 year and 6 months (*IQR 8 months to 5 years*). Permanent day shift nurses have been working shifts altogether the longest for a median of 13 years and 6 months (*IQR 10 years and 5 months to 16 years and 9 months*), while permanent night (*IQR 6 years to 25 years*) and rotating (*IQR 6 years to 21 years*) shift nurses have both worked for a median of 10 years. Across the three shift arrangements, most permanent night (n=15 ;75%), rotating nurses (n =12; 92.31) and permanent day (n = 16; 88.89) shift nurses did not work a second paid job. Rotating nurses had the longest career break of a median of 10 months (*IQR 5 months to 3 years*), followed by permanent day shift nurses with a

median of 6 months (*IQR 0 years to 1 year and 6 months*), with permanent night nurses having the shortest median career break of 1 month (*IQR 0 years to 5 months*).

Table 6: Professional experience of nurses for the general sample and per shift type, including category of nurse, years working as a nurse, working in the present shift system, working shifts altogether, moonlighting, and career break

	All nurses		**Permanent night**		**Rotating**		**Permanent day**	
Variables	**N (%)**	***Mdn* (IQR 25-75%)**	**N (%)**	***Mdn* (IQR 25-75%)**	**N (%)**	***Mdn* (IQR 25-75%)**	**N (%)**	***Mdn* (IQR 25-75%)**
Nurse Category	**51(100)**		**20 (100)**		**13 (100)**		**18 (100)**	
Registered Professional Nurse (RPN/RN)	36 (70.59)		14 (70)		8 (61.54)		14 (77.78)	
Registered staff nurse (RSN/EN)	9(17.65)		4 (20)		3 (23.08)		2 (11.11)	
Registered auxiliary Nurse (RAN/ENA)	6(11.76)		2 (10)		2 (15.38)		2 (11.11)	
Nursing career (years and months)	51 (100)	15 (8-29)	20 (100)	10.5 (6.5-35)	13 (100)	20 (7-23)	18 (100)	15.5 (13-30)
Nursing in the present shift system (years and months)	51 (100)	4 (1-9)	19 (95)	1.5 (0.67-5)	13 (100)	5 (1-10)	18 (100)	6 (2-13)
Working shifts altogether (Years and months)	48 (94.12)	11.25 (6.3-21)	19 (95)	10 (6-25)	13 (100)	10 (6-21)	16 (88.89)	13.5 (10.5-16.75)
Second paid job	**51 (100)**		**20 (100)**		**13 (100)**		**18(100)**	
Yes	8 (15.69)		5 (25)		1 (7.69)		2 (11.11)	
No	42 (84.31)		15 (75)		12 (92.31)		16 (88.89)	
Career break (years and months)	26 (51)	0.33 (0-1)	10 (50)	0.07 (0-0.45)	6 (46.15)	0.84 (0.42-3)	10 (55.56)	0.54 (0-1.58)

4.3.2. Partners' work schedule and perception of nurses shift work

Referring to nurses' partners work hours in Table 7, for the general sample, nurses' partners worked a median of 40 hours per week (*IQR 40 hours to 42 hours*). Most partners (*n* = 14; 60.87%) worked a daytime job with no shifts. Most nurses' partners (*n* = 15;

51.72%) were “fairly supportive” of nurses’ working shifts. Similar to the general sample, most nurses’ partners across the three shift systems worked day jobs without shifts and were “fairly supportive” of them working shifts.

Table 7: Nurses' partners work hours per week, work schedule and perception of nurses working shift from section two of the SSI

	All nurses		**Permanent night**		**Rotating**		**Permanent day**	
Variables	**N (%)**	***Mdn* (IQR 25-75%)**	**N (%)**	***Mdn* (IQR 25-75%)**	**N (%)**	***Mdn* (IQR 25-75%)**	**N (%)**	***Mdn* (IQR 25-75%)**
Partner hours (Hours,min) per week	**21 (41)**	**40 (40-42)**	**4 (20)**	**41(40-45)**	**5 (38.46)**	**40 (40-42)**	**12 (66.67)**	**40 (35-43.5)**
Partner's work pattern	**23 (45.1)**		**7 (35)**		**5 (38.46)**		**12 (66.67)**	
Daytime-no shifts	14 (60.87)		4 (57.14)		2 (40)		9 (75)	
Rotating shifts with nights	4 (17.39)		1 (14.28)		2 (40)		1 (8.33)	
Rotating shift without nights	1 (4.35)		1 (14.28)		0		0	
Permanent night shift	1 (4.35)		0		1 (20)		0	
Not applicable	2 (8.7)		1 (14.28)		0		1 (8.33)	
Other	1 (4.35)		0		0		1 (8.33)	
Partners’ feelings towards working shifts	**29 (56.86)**		**10 (50)**		**8 (61.54)**		**13 (72.22)**	
Extremely unsupportive	2 (10.53)		0		1 (80)		1 (7.69)	
Fairly unsupportive	0 (0)		0		0		0	
Quite indifferent	1 (5.26)		0		1 (80)		0	
Fairly supportive	15 (51.72)		6 (60)		4 (50)		7 (53.85)	
Extremely supportive	11 (37.93)		4 (40)		2 (25)		5 (38.46)	

4.3.3. Commuting time and methods

This section displays information regarding the commuting times to and from work for nurses, the mode of transport used, and perceptions of safety around commuting to the different shifts.

4.3.3.1. Travel time

With reference to the commuting time of nurses in Table 8, night shift nurses travel longer to and from shifts in total, while no significant differences were found. Comparing the different shift arrangements, rotating nurses are travelling longer in total on night shifts. Similarly, rotating nurses are travelling longer in total on day shifts. No significant differences in travel time were found between the different shift arrangements.

Table 8: Commuting times (minutes) to and from shifts for nurses of the general sample, and for the different shift arrangements across the three healthcare facilities

Variable	**All nurses**		**Permanent night**		**Rotating**		**Day**	
Shift Type	**N (%)**	***Mdn* (IQR25 - 75%)**	**N (%)**	***Mdn* (IQR25 - 75%)**	**N (%)**	***Mdn* (IQR25 - 75%)**	**N (%)**	***Mdn* (IQR25 - 75%)**
Day shift								
To	39 (76.47)	15 (10 - 20)			13(100)	15 (10 - 30)	18 (100)	15 (10 - 20)
From	35 (68.63)	15 (10 - 30)			11(84.62)	25 (10 - 30)	16 (88.89)	16.25 (12.5 - 25)
Total commute	35 (68.63)	31.75 (20 - 40.63)				40 (18.5 - 60)	16 (88.89)	34.25 (27.5 – 40.64)
Night shift								
To	31 (60.78)	15 (10 - 30)	17 (85)	12.5 (8.5 - 15)	11(84.62)	20 (10 - 30)		
From	31 (60.78)	20 (12 - 30)	17 (85)	15 (10 - 20)	11(84.62)	25 (10 - 30)		
Total commute	31 (60.78)	35 (20 -55)	17 (85)	30 (20 - 40)	11 (84.62)	40 (20 - 60)		

4.3.3.2. Mode of transport

With reference to the mode of transport used by nurses (see Figure 12), the majority of nurses use private transport to commute to and from work across the three healthcare facilities (*n* = 31; 60.78%), while the rest of the nurses who responded used public transport (n =8; 15.69%), a combination of public and private transport (*n* = 4; 7.84%) or commuted by foot (*n* =4; 15.69%).

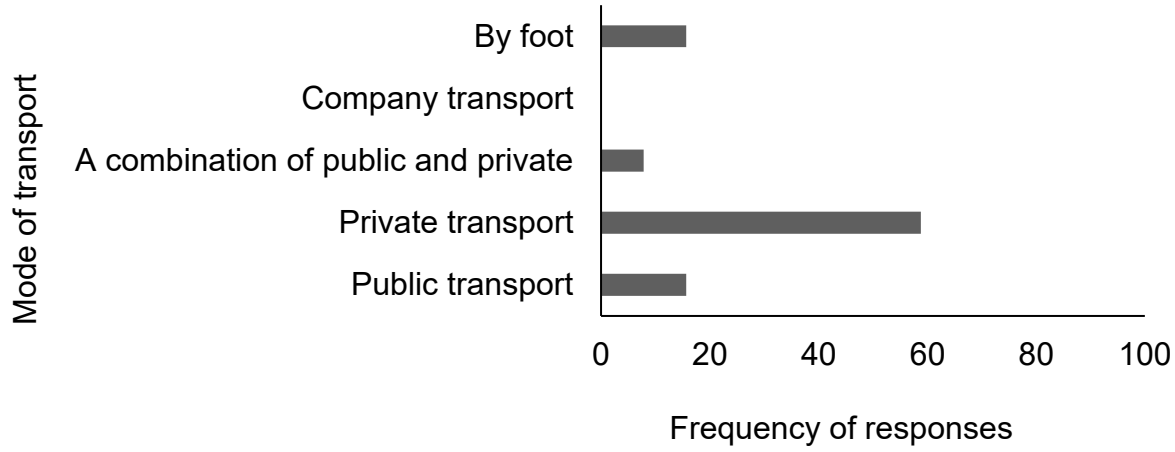

Figure 12: Mode of transport used by nurses to commute daily (*n* = 51; 100%)

With reference to the mode of transport used by nurses across the three shifts (as shown in Figure 13), nurses predominantly used private transport to commute to and from work, whilst sometimes using public transport, a combination of public and private, or commute by walking. Comparing all three shift types, a significant difference ***H* (2) = 10.49, *p* = 0.0165** was found between permanent night and rotating shift nurses, showing that rotating nurses were more likely to use private and public transport more than permanent night nurses.

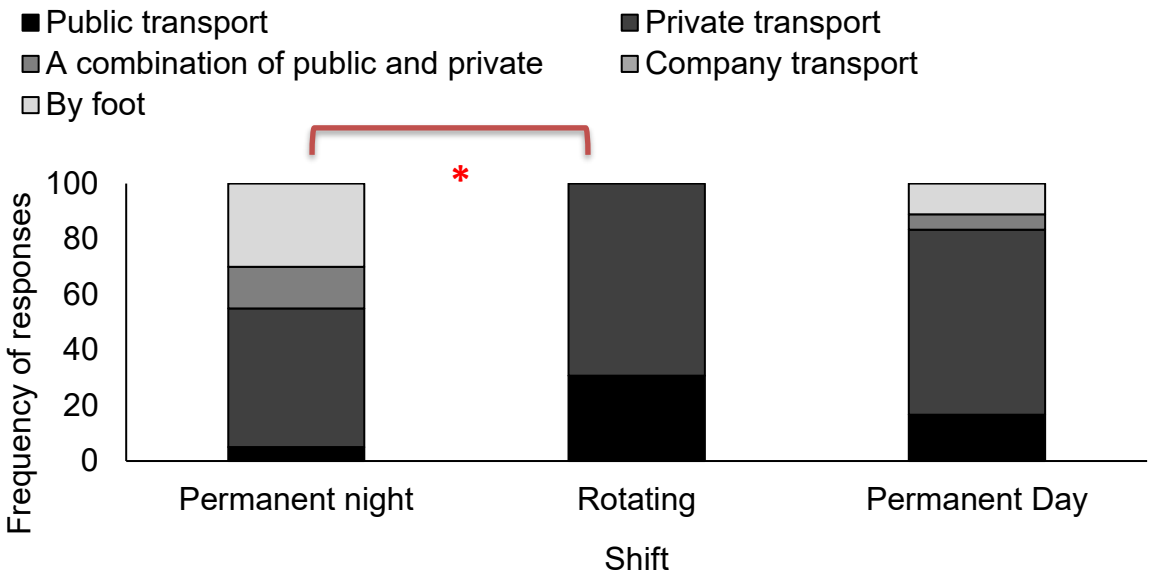

Figure 13: Mode of transport used by nurses working permanent night (*n* = 20; 39.22%), rotating (*n* = 13; 25.49%), and day shift (*n* = 18; 35, 29%)

Nurses across the three facilities generally feel safe (see Figure 14) while commuting to and from work for different shifts. Safety concerns (quite often), however, increased when commuting to night shift (*n* = 9; 24.32%) compared with commuting to day shift (*n* = 3; 8.33%).

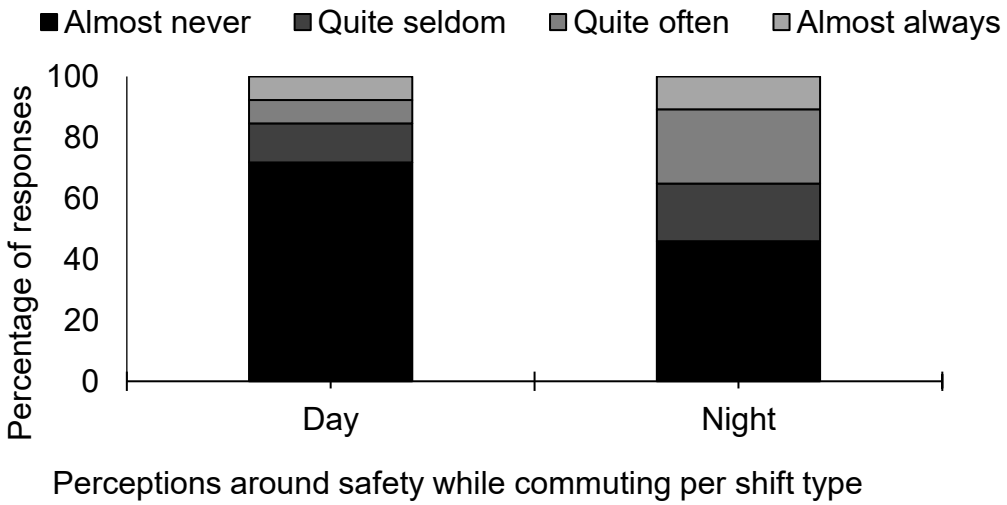

Figure 14: Nurses' perceptions of safety when commuting between different day (*n* = 39; 76.48%) and night (*n* = 37; 72.55%) shifts, across the three healthcare facilities (*n* = 50)

4.4. SLEEP-WAKE BEHAVIOURS

This section of results displays the sleep-wake behaviours of all nurses separated into the different shifts. Discussed below are the sleep onset and wake times, and

subsequent sleep duration, reported required amount of sleep for adequate daily functioning, sleep quality and disturbances, naps taken on shift or on the day of shift, and the use of sleeping aids.

4.4.1. Sleep duration

With reference to the sleep durations in Table 9, all nurses have reported needing a median of 7 hours and 30 minutes (*IQR* 7 to 8 hours) of sleep per day for daily functioning. The sleep and wake times informing the sleep duration obtained by nurses shows that all nurses working day shifts are sleeping for 15 minutes less than on days off and 30 minutes less than the self-reported required amount of sleep. Similarly, nurses working night shifts are sleeping for 1h and 15 min less than on off days and sleeping 1 hour and 30 minutes less than the self-reported amount of sleep needed. Nurses working day shifts slept 30 minutes later on days off, while night shift nurses reported sleeping at night on off days, instead of during the day. Nurses working day shifts woke up 2 hours and 15 minutes later on days off, while night shift nurses woke up 7 hours and 45 minutes earlier on days off.

Table 9: Sleep and wake times, sleep duration and reported sleep required for all shift nurses, and nurses working the three different shifts.

Variable	**All shift nurses**	
Sleep Times	**N (%)**	***Mdn* (IQR25-75%)**
Day shift	36 (70.59)	22h00 (22h00-22h30)
Night shift	30 (58.82)	09h00 (08h30-10h00)
Days off	41 (84.31)	22h30 (22h00-23h00)
Wake times		
Day shift	35 (68.63)	05h00 (04h30-05h15)
Night Shift	30 (58.82)	15h00 (13h00-16h00)
Days off	46 (90.2)	07h15 (06h00-09h00)
Sleep duration		
Day shift	38 (74.51)	7 (6.5-7)
Night shift	25 (49.02)	6 (5-7.5)
Days off	42 (82.35)	7.25 (7.75-11)
Reported sleep required	45 (88.24)	7.5 (7-8)

With reference to the sleep and wake times, and self-reported sleep durations shown in Table 10, only comparisons between those who work the same type of shift could be made.

Table 10: Sleep and wake times, sleep duration and reported sleep required for nurses working permanent night, rotating and day shifts. ***a*** denotes a significant difference (p<0.05) between permanent and rotating nurses, and ***b*** denotes a significant difference (p<0.05) between rotating and day shift nurses, on days off

	Permanent night		Rotating		Day	
Variable	**N (%)**	***Mdn* (IQR25-75%)**	**N (%)**	***Mdn* (IQR25-75%)**	**N (%)**	***Mdn* (IQR25-75%)**
Sleep Times						
Day shift			12 (92.31)	22h08 (22h00-22h30)	15 (83.33)	22h00 (22h00-22h30)
Night shift	17 (85)	09h00 (08h30-10h00)	10 (76.92)	09h45(09h00-11h00)		
Days off	18 (90)	22h15 (21h00-23h00)	12 (92.31)	22h23(21h00-23h00)	13 (72.22)	22h00 (22h00-23h00)
Wake times						
Day shift			12 (92.31)	04h45 (04h15-05h00)	15 (83.33)	05h00 (04h30-05h30)
Night Shift	17 (85)	15h00 (13h00-16h00) **a**	10 (76.92)	16h30 (16h00-17h00) **a**		
Days off	19 (95)	08h00 (06h00-09h00)	13 (100)	08h00 (06h30-09h00)	14 (77.78)	06h30 (05h30-07h30)
Sleep duration						
Day shift			12 (92.31)	6.63 (6.13-7)	13 (72.22)	7 (6.5-7)
Night shift	14 (70)	6 (5-8.5)	8 (61.54)	7 (6.63 – 7.75)		
Days off	19 (95)	8 (6-9)	11 (84.62)	11 (8-12.5) **b**	13 (72.22)	8 (7-9) **b**
Reported sleep required	18 (90)	7 (7-8)	13 (100)	8 (7.5-8)	14 (77.78)	7.5 (7-8)

Permanent night nurses (*Md* = 15h00, n = 17) reported waking up significantly earlier than rotating nurses after a night shift **(a) *U* = 14.5, *z* = 3.52 *p* = 0.0004**. Looking at sleep duration, rotating shift nurses reported sleeping significantly longer (*Md* = 11, n = 11) than day shift nurses on days off **(b) *U* = 36.5, *z* =-1.999, *p* = 0.045**. There were no other significant differences between the different shift types.

4.4.2. Sleep disturbances

With reference to sleep disturbances displayed in Table 11, nurses in the overall sample reported experiencing low sleep disturbance with a median score of 34 (*IQR* 22 to 62*)*. Nurses working day shifts experienced higher sleep disturbances with a median score of 18 (*IQR* 14 to 21) than nurses working night shifts 16 (*IQR* 14 to 21*).* Nurses experience low disturbances on days off with a median score of 14 (*IQR* 12-18) No significant differences were found between day and night shifts, while significant differences were found for sleep disturbances on days off ***H* (2) = 6.02, *p* = 0.049.**

Table 11: Total sleep disturbance scores and sleep disturbance score per shift for all shift nurses (a higher score indicates greater sleep disturbances)

	All Shift nurses	
Variable	**N (%)**	***Mdn* (IQR25-75%)**
Total Sleep disturbance score	49 (96.07)	34 (22-62)
Sleep disturbance per shift		
Day	37 (72.55)	18 (14-21)
Night	34 (66.67)	16 (14-21)
Days Off	40 (78.43	14 (12-18) *

With reference to the sleep disturbances of nurses working different shift arrangements in Table 12, nurses who work rotating nights have greater total sleep disturbances compared with permanent night and day shift nurses, however no significant differences were found between the different shift arrangements for the total sleep disturbance score, on day shifts, or on night shifts. Rotating nurses however, had significantly more disturbances on days off **(c) *U* = 47.5, z = 2.23, p = 0.026** (Appendix G) compared with permanent night nurses. When comparing the individual questions determined the sleep disturbance scores, rotating shift nurses had significantly poorer sleep quality than permanent night nurses on days off ***U* = 40.5, *z* = 2.21, *p* = 0.026** (Appendix G).

.

Table 12: Sleep disturbance scores for nurses working permanent nights, day shift with rotating nights, and nurses who are unassigned to a specific shift. **c** denotes a significant difference ($p<0.05$) between permanent night and rotating nurses.

	Permanent night shift		Rotating shift		Day shift	
Variable	**N (%)**	***Mdn* (IQR25-75%)**	**N (%)**	***Mdn* (IQR25-75%)**	**N (%)**	***Mdn* (IQR25-75%)**
Total Sleep disturbance score	20 (80)	27.5 (21.5-40.5)	13(100)	43 (29.25-53.63)	16(88.89)	32 (21-50.5)
Sleep disturbance per shift						
Day			12(92.31)	19.5 (17.5-22.5)	16(88.89)	15 (13-21)
Night	16 (80)	16 (15-18)	11(84.62)	18 (16-23)		
Days Off	16 (80)	12.5 (9.5-16) **c**	12(92.31)	17.5 (15-21) **c**	12(66.67)	12 (0-14)

4.4.3. Naps

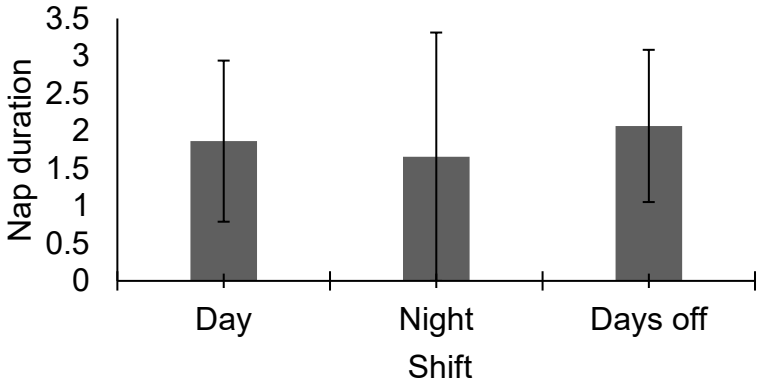

Figure 15: Average duration of naps taken by nurses either at work or at home across the three healthcare facilities for day (*n* = 11; 21.57) and night shifts (*n* = 8; 15.69), and days off (*n* = 15; 29.41)

With reference to naps taken on or off duty in Figure 15 above, while no significant difference were found, nurses reported having longer naps on days off (2 h and 4 min ± 1 h and 1min) compared to day (1 h and 52 min ± 1 h and 4 min) and night shifts (1 h 40 min ± 1 h and 5 min).

4.4.4. Sleeping aids

With reference to the use of sleeping pills, the majority of nurses “almost never” used sleeping pills to fall asleep between successive day shifts (*n* = 26; 79%), successive night shifts (*n* = 23; 81.25%) and successive days off (*n* = 27; 79.41%). No significant differences were found between different successive shifts/days off.

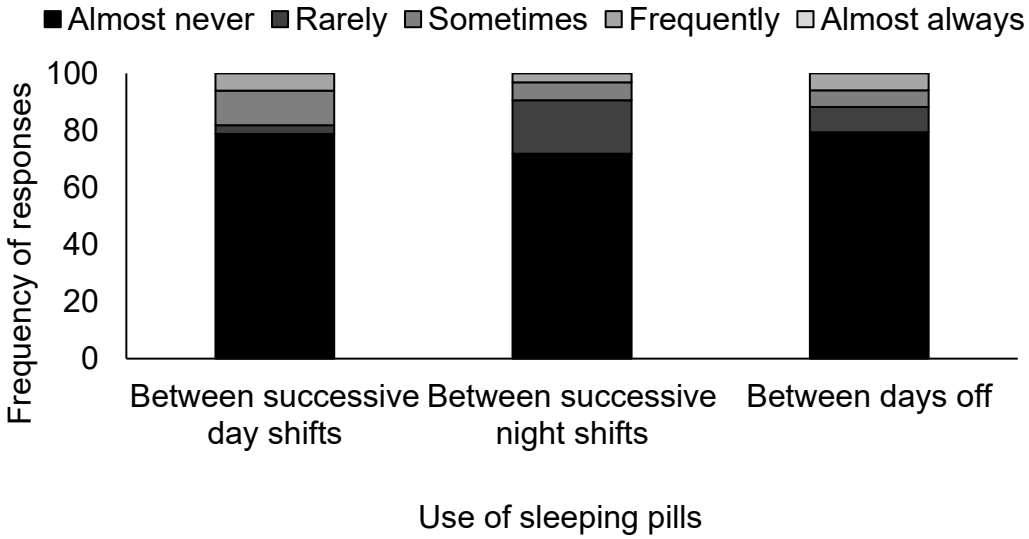

Figure 16: Use of sleeping pills between successive day (*n* = 33; 68.63%), night shifts (*n* = 32; 60.78%), and days off (*n* = 34; 66.67%) by nurses employed at the three healthcare facilities

With reference to the use of alcohol to sleep in Figure 17, the majority of nurses “almost never” used alcohol to sleep between successive day shifts (*n* = 32; 94.12%), successive night shifts (*n* = 31; 93.93%), or successive days off (*n* = 30; 80.71). No significant differences were found between the different successive shifts/days off.

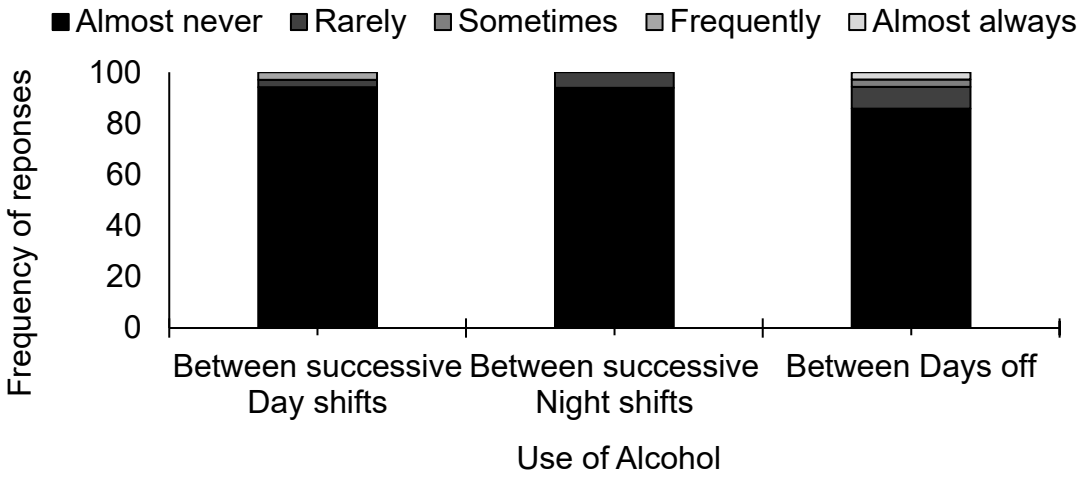

Figure 17: Nurses' use of alcohol to sleep on the between successive day (*n* = 34;66.67%), night shifts (*n* = 33;64.71%), and days off (*n* = 35;68.63) employed at the three healthcare facilities

4.5. WORKLOAD

The results below describe the physical and mental workload, emotional stress and time pressure experienced by all nurses in comparison with colleagues, as well as nurses working the three different shifts.S

Table 13: Shift nurses the nurses' perceived physical and mental workload, emotional stress and time pressure in comparison with colleagues of the same workload, across the three private facilities. *Likert scale responses score from 1= Extremely light to 5= extremely heavy*

Variable	**All shift nurses**	
Workload	***N (%)***	***Mdn (IQR25-75%)***
Physical		
Day	38 (74.51)	4(3-4)
Night	36 (70.59)	3(3-4)
Mental		
Day	37 (72.51)	4 (3-4)
Night	37 (72.51)	3 (3-4)
Emotional stress		
Day	38 (74.51)	3 (3-4)
Night	36 (70.59)	4 (3-4)
Time pressure		
Day	38 (74.51)	3 (3-4)
Night	38 (74.51)	4 (3-4)

With reference to workload variables in Table 13 above, all shift nurses reported that their physical and mental workload on day shift was greater than night shift; whereas they found that emotional stress and time pressure was greater during night shift compared with day shift.

No significant differences were found for the four variables displayed in Table 4 between day and night shifts.

With reference to the different workload variables displayed in Table 14, no significant differences for all workload variables were found between groups. Permanent day shift nurses reported the highest median physical workload of 4 (*IQR* 3 to 4) between the three different shift arrangements. Permanent night shift nurses and day shift nurses both reported that their mental workload was heavier during their respective shifts (both *Md* = 4; *IQR* 3 to 4) compared to rotating shift nurses working both day and night shifts. Rotating shift nurses and permanent day nurses reported similar emotional stress and time pressures that were "quite heavy", more than permanent night nurses, while permanent day nurses reported higher physical and mental workloads compared with rotating nurses and mental workload was reported to be "about the same" for both day and night shifts.

Table 14: Nurses' perceived physical and mental workload, emotional stress and time pressure in comparison with colleagues of the same workload when working separated by the type of shift worked. *Likert scale responses score from 1= Extremely light to 5= extremely heavy.*

Variable	**Permanent night**		**Rotating shift**		**Permanent day**	
Workload	***N (%)***	***Mdn (IQR25-75%)***	***N (%)***	***Mdn (IQR25-75%)***	***N (%)***	***Mdn (IQR25-75%)***
Physical						
Day			12 (92.31)	3.5 (3-4)	17 (94.44)	4 (3-4)
Night	17 (85)	3 (3-4)	12 (92.31)	3 (3-3.5)		
Mental						
Day			12 (92.31)	3.5 (3-4.5)	17 (94.44)	4 (3-4)
Night	17 (85)	4 (3-4)	11 (84.62)	3 (3-5)		
Emotional stress						
Day			12 (92.31)	4 (3-4.5)	17 (94.44	4 (4-4)
Night	15 (75)	3 (2-4)	12 (92.31)	4 (3-4)		
Time pressure						
Day			12 (92.31)	4 (3-4)	17 (94.44)	4 (3-4)
Night	17 (85)	3 (3-4)	11 (84.62)	4(3-4)		

4.6. CHRONIC FATIGUE

With reference to chronic fatigue scores displayed in Table 15, day shift nurse working rotating shifts scored higher on the chronic fatigue score (*Md* = 30; *IQR* 21 to 30) than permanent night and permanent day shift nurses, with permanent night nurses (*Md* = 24; *IQR* 18.5 to 30.5) experiencing the least chronic fatigue. However, there were no significant differences across the different shift types.

Table 15: chronic fatigue scale scores for all nurses, and nurses working permanent night, rotating, and day shifts. A higher score indicates greater chronic fatigue.

	Chronic fatigue score	
All shift nurses	***N(%)***	***Mdn (IQR 25-75%)***
	37 (88.23)	28 (18-30)
Shift type	**N(%)**	***Mdn* (IQR 25-75%)**
Permanent Night shift	16 (80)	24 (18.5-30.5)
Rotating nurses	11 (84.62)	30 (21-32)
Permanent Day shift nurses	10 (55.56)	27 (16-33)

When asked “what other observations around sleep and fatigue that were not covered in the sleep disturbance questionnaire and chronic fatigue scale (*n* =13; 25.49%)., it was reported that if nurses chose to work shifts, they did not experience any changes to their sleep and fatigue. Otherwise, nurses reported disturbances such as insomnia, sleep fragmentation, and general tiredness.

4.7. MORNINGNESS/EVENINGNESS

Regarding the morningness/eveningness or chronotype scores of the nurses in Table 16 below, *n* = 28 (62.22%) nurses in the general sample scored between 23 and 43 indicating that nurses are more likely to be an intermediate chronotype, while the rest are considered “morning type” (*n* = 16; 36.36%). No evening chronotypes were identified. More permanent night nurses were identified as intermediate chronotypes (*n* = 13; 68.42%) in comparison with rotating (*n* = 8; 61,54%) and day shift nurses (*n* = 8; 53.33%).

Table 16: Chronotype of nurses working permanent night shift, day shift with rotating nights, and nurses unassigned to a specific shift. Evening types have a score of ≤22, intermediate scores are between 23-43, and Morning type scores are ≥44

Variables	Chronotype		Morning	Intermediate
	N (%)	Mean (±SD)	N (%)	N (%)
All shift nurses	45(88.24)	40 (± 5.66)	17 (37.78)	28 (62.22)
Shift Type				
Permanent Night shift	19 (95)	39 (± 5.78)	6 (31.58)	13 (68.42)
Rotating shift	11 (84.62)	40 (± 4.16)	3 (27.27)	8 (72.72)
Permanent Day shift	15 (83.33)	42.4 (± 6.33)	8 (53.33)	7 (46.67)

CHAPTER V
DISCUSSION

5.1. OVERVIEW

This chapter discusses the key findings and implications of the results obtained in relation to the objectives of this study. Due to the limited research regarding the different shift arrangements used in healthcare in South Africa, it was imperative to contextualise and understand the impact of the current shift work arrangements on private health care nurses' self-reported sleep-wake behaviours and fatigue.

The first aim was to characterize the shift arrangements adopted by three private healthcare facilities. The second objective was to determine the impact of the different shift arrangements on the relevant nursing group's sleep-wake behaviours and fatigue. Throughout, findings from the thematic analysis are included in the discussion of quantitative data. Regarding hypothesis one the researcher tentatively rejects H_0 and accepts H_1 as there is a difference between the shift arrangements and sleep wake-behaviours. Regarding the second hypothesis, the researcher accepts H_0 and rejects H_1 as there was no difference between shift arrangements and fatigue experienced by nurses.

Key findings of the general sample that work shifts (day and/or night) are discussed first, followed by the key findings of specific shifts arrangements (permanent night shift, rotating shift, and permanent day shift).

5.2. KEY FINDINGS OF THE GENERAL SAMPLE

5.2.1. Shift characteristics

The 51 nurses who completed the questionnaire reported working mostly regular 12-hour day and/or night shifts, where day shifts start at 07h00 and end at 19h00, and night shifts start at 19h00 and end at 07h00. Nurses in the general sample worked a median of 42 hours per week, working up to 12 hours of paid overtime and two to seven hours of unpaid overtime per week (Table 3). In the general sample, nurses working day shifts reported working a range of two to five successive shifts, while nurses working nights work more consecutive shifts ranging between five and seven. Nurses working night shifts work a median of 165 nights a year. The general sample reported a range of two to six successive days off.

In support of the findings of this study, regular shift systems are more common in healthcare (Ball *et al.*, 2017; Costa et al, 2014; Dall'Ora *et al.*, 2022), where the start and end times were the same as other studies on hospital nurses in other contexts (Petrov *et al.*, 2014; Rogers *et al.*, 2004; Wilson *et al.*, 2019), and a review on nurses in European countries (Garde *et al.*, 2019). Regular shift systems are necessary in healthcare to ensure the continuity of staff to provide care over a 24-hour period (Ball *et al*., 2017), especially when there is a shortage of nurses (Griffiths *et al*., 2014). With reference to the number of successive shifts, the findings of this study were similar to consensus from a review by Garde and colleagues (2019), where night shift nurses worked five or more consecutive shifts, while nurses in other studies worked nights for two (Haluza *et al*., 2018) or three consecutive shifts. Paid and unpaid overtime is less in this sample of nurses compared to a study on Egyptian nurses (Saleh *et al.*, 2018), but given that this was only one question, it may be difficult to determine why this difference existed.

The general sample of nurses in this study felt that they had better control of their shift system, with a little less than 60% of nurses' responses between "a fair amount" and "complete" control over their shift system. On the other hand, the general sample felt that they had less control over the start and end times of their shift systems, with a little over 60% of responses between "none" and "a fair amount". Looking more deeply into control over the shift system, nurses could request to work specific shifts more than they were required to swop shifts with colleagues or required to change the roster on short notice, indicating some degree of flexibility, albeit not much. With less control over shift systems, nurses may have less opportunities for recovery, sleep and reducing fatigue (Edéll-Gustafsson et al., 2002; Gander et al., 2019; Gifkins et al., 2020). The implications of this will be discussed later in this chapter.

When establishing the reasons for nurses working shifts, most responses included: part of the job, convenient for their domestic responsibilities, and higher rates of pay. Nurses, regardless of the type of shift they worked, found that their regular shift system allowed them to plan daily and weekly activities to suit their various domestic and personal responsibilities, as well as giving them an opportunity to spend time with their families and to attend to their domestic responsibilities. In addition, the reason of "higher rates of pay" is supported by excerpts of the advantages where nurses expressed receiving higher rates of pay associated with working night shifts.

The nurses' reasons for working shifts in this sample are similar to those found in other studies (McElroy *et al.*, 2020; Zion *et al.*, 2018) where nurses worked shifts because they were convenient for domestic responsibilities. Also like this study, Zion and colleagues (2018) found that nurses, particularly those who choose to work night shifts, are better able to plan and match their shift schedules with various daily and social activities, and domestic responsibilities. However, this was not consistent with some of the disadvantages outlined by some nurses, particularly around how their shift system interfered with their ability to fulfil certain domestic and social obligations. These findings support a range of literature that has reported the impact that shift work may have on work-life balance (Geiger-Brown, *et al.*, 2012; Korsiak *et al.*, 2017; Saksvik *et al.*, 2011; West *et al.*, 2016), but given that it was not a central focus of this study, more detailed and targeted research in this area is warranted.

5.2.2. Sleep-wake behaviours of the overall sample

5.2.2.1. Sleep duration

Respondents in the general sample reported needing a median of seven and a half hours of sleep for adequate daily functioning, with sleeping time reported for the day shift and night shifts being less than that required. This was supported by the disadvantages of shift systems where nurses complained of not having enough time for sleep and recovery.

While there may be many reasons for this observation, in the general sample, nurses reported working 12-hour regular shifts, while working up to 12 hours of paid overtime and up to 7.26 hours of unpaid overtime per week in addition to working 12-hour shifts. This is supported by an excerpt from the disadvantages of nurses' shift systems (Figure 9) where nurses reported working up until 21h00, two hours after the shift has ended. While regular shift systems give nurses greater opportunity for rest and recovery (Gao *et al.*, 2020), extended hours of work (12-hours), often result in extended periods of wake, and thus shorter periods available for sleep (Knauth, 2007). Twelve-hour shift workers, particularly night workers, often need to adjust their sleep onset and wake times to accommodate for working long hours (Costa, 2010; Knauth, 2007; Rosa *et al.*, 1996). Furthermore, overtime is common in healthcare with previous research highlighting that it is often a time during which nursing staff compete managerial and administrative tasks (Rogers *et al.*, 2004; Saville *et al.,* 2020; Stimpfel

et al., 2012). which in turn contributes to a shortened overall time for recovery post shift (Åkerstedt & Wright 2009; Williamson & Friswell, 2013) and shorter sleep durations (Saleh *et al.,* 2018). Thus, it is plausible that both day and night shift nurses are consistently working beyond 12-hours extended their period of wake, shifting their sleep onset time, and subsequent shorter sleep, which may explain why all nurses are sleeping less than their self-reported needed sleep.

With specific reference to nurses who reported working night shifts, this group reported sleeping less than the self-reported required sleep needed and less than the generally recommended amount of sleep. In comparison to other studies (Geiger-Brown *et al.*, 2012; Hirsch-Allen *et al.*, 2014; James *et al.*, 2020; Molzof *et al.*, 2019), nurses working night shifts in this sample reported sleeping slightly longer (between 15-40 minutes), however still less than the recommended hours of sleep. This may have been due to the fact that the sleep duration, in this study, was calculated by the bed and wake times and did not consider any sleep latency measures. In contrast to the findings of this study, two studies found that night nurses were receiving seven hours of sleep, in line with the recommend sleep (Heath *et al.*, 2019; Wilson *et al.*, 2019).

Shorter sleep found among night shift workers has previously been attributed to working when biologically inclined to sleep (Monk, 1989), and sleep during a period of circadian wake (Niu *et al.*, 2017). Additionally, studies have stated that when night shift nurses are attempting to sleep during the day, they are often interrupted by the daily activities of members of the household, noise, and an exposure to light and ambient temperature (Niu *et al.*, 2017), which was consistent with the disadvantages outlined by some nurses in this study, particularly around the negative impact the noise, light and ambient temperature had on sleep. Furthermore, the shorter sleep in those who worked night shift may have been due to the longer commute that some night nurses had to make, in comparison to those who worked day shift. It is plausible to infer that nurses working night shifts in this sample are sleeping less due to both circadian desynchrony and exposure to exogenous factors restricting sleep following night shifts.

With regard to day shift nurses, this group reported sleeping (on average) 30 minutes less than the self-reported required sleep needed. Sleep duration for day shift nurses of seven hours in this study was similar to the findings of other studies on nurses in

other contexts (Dorrian *et al.*, 2006; Wilson *et al.*, 2019), while receiving 15 (Hirsch-Allen *et al.*, 2014), and 20 (James *et al.*, 2020) minutes more than other groups of American day shift nurses, and 1 hour and 15 minutes more than another group of nurses working day shift (Geiger- Brown *et al.*, 2012). The reasons for day shift nurses obtaining shorter sleep are less obvious than those for night shifts nurses but may be the result of these nurses having to wake up early (a median of 05h00) to get to work on time. Previous research has highlighted that early starts often result in truncated sleep due to people struggling to fall sleep, sleeping fitfully and prematurely waking before they should (Costa, 2010).

All shift nurses, regardless of the shift worked, were sleeping more on days off than the self-reported required sleep, with some nurses in the overall sample sleeping for up to 11 hours. This corresponds with previous research which found that nurses often receive less sleep on duty days than on off duty days (Dorrian *et al.*, 2011; James *et al.*, 2020; Madide, 2003), with a duration of up to nine hours of sleep being quite common on days off. Nurses in this sample are sleeping less on days off compared with previous studies (Hirsch-Allen *et al.*, 2014; James *et al.*, 2020; Molzof *et al.*, 2019) whose nurses slept for eight hours, and more sleep than shift nurses in one study (Geiger-Brown *et al.*, 2012). The longer sleep duration on days off is in alignment with previous literature that has reported on the effects of 12-hour shifts, where sleep loss may accumulate over consecutive shifts. In this study, ay shift nurses reported working up to five consecutive shifts, and night shift workers working up to seven consecutive shifts. Previous research has reported that sleep loss can accrue over consecutive shifts, particular shifts that involve having to work at night and wake early (Geiger-Brown *et al.*, 2012). While not explored explicitly in this study, it plausible that nurses may have been suffering from sleep debt as a result of accumulative sleep loss on duty days, which in turn warranted nurses sleeping longer on rest days (catching up on sleep) (Dorrian *et al.*, 2011; Overeem *et al.*, 2007; Wilson *et al.*, 2019). Future research should explore this in more detail and determine whether any cumulative deficits in sleep are associated with changes in performance ability, given that this may influence the delivery of care.

5.2.2.2. Sleep disturbances of the general sample

The general sample of nurses was found to be experiencing low-medium total sleep disturbances. While there were no significant differences found between day and night

shifts, disturbances for nurses working day shifts were higher than for those working night shifts, with nurses experiencing the least disturbances on days off.

In relation to previous research, the total sleep disturbance score for the general sample in this study was considerably lower compared with other studies (Korompeli *et al.*, 2013; Korompeli *et al.*, 2014), slightly lower than one study (Costa *et al.*, 2014), and moderately higher than another study (Saleh *et al.*,2018).

This finding was unexpected as previous research has noted that nurses working night shifts experience greater disturbances to their sleep due to circadian (Costa, 2010), environmental and lifestyle factors (Korompeli *et al.*, 2013; Niu *et al.*, 2017; Zion *et al.*, 2018). The higher sleep disturbances in the day workers may be explained by the disadvantage expressed by some day nurses was that number of days off were insufficient and that days off were not a long enough period for rest, especially on weekends which may explain the higher disturbances among day shift nurses even though there were no significant differences. Furthermore, nurses in this sample reported that often tend to family and complete domestic chores after their shift, which may be contributing total sleep time and sleep disturbances, however this was not explicitly explored in this study and warrants future research. Overall, the lack of significant differences between the different shifts may be explained by the regularity of shift systems, which enable nurses to plan their rest and recovery in relation to their respective shift schedules.

5.2.2.3. Workload of the general sample

In the general sample, nurses working day shifts experienced higher reported physical and mental workloads compared with night shift nurses, while the latter experienced greater emotional stress and time pressure than day shift nurses, even though this was not statistically different. The moderate to high workload observed across the different shifts may be explained by some of the disadvantages that nurses shift systems where nurses felt they were working under pressure and that the workloads on 12-hour shifts are heavy. The reported high workloads, emotional stress and time pressures for the general sample were likely due to the dynamic and sometimes unpredictable nature of nursing, the different levels of care required for different patients and the non-patient related work across the different facilities (Alghamdi, 2016; Halter *et al.*, 2017; Hayes *et al.*, 2012), at a time when health care was under

severe strain due to the effects of the COVID-19 pandemic. While there were no significant differences, physical and mental workloads were higher among those who worked day shifts compared to those who reported working night shifts, thus it is plausible to attribute higher physical and mental workloads for day shift nurses to more direct patient care during the day. Similarly, while not explored explicitly in this study, patients are usually asleep during night shift, resulting in less direct patient care that involves physical and mental exertion (West *et al.*, 2016).

Although not significant, an interesting finding is that nurses working night shifts reported experiencing higher emotional stress and time pressures than nurses working day shifts. It was expected that increased direct patient care during the day involving more emotional support to patients would result in higher emotional stress/emotional exhaustion for nurses working day shifts (Aslani & Bahmani, 2020; Dall'Ora *et al.* 2020; Stimpfel *et al.,* 2012). Nurses working nights in the general sample expressed that their colleagues did not always act professionally and that there is a level of disrespect on duty, which may further contribute to emotional stress. Nurses in the general sample stated that patients may be confused and there is a higher chance of falling-incidents at night, which may contribute to the emotional stress experienced (also supported by West and colleagues, 2016). In addition, nurses working night shifts stated a shortage of staff as a disadvantage of their shift system and that changes in rostering may occur on short notice. Although not assessed in this study, these organisational factors may add to the time pressure of night nurses as there are not enough nurses to efficiently distribute tasks to be completed timeously. It is reasonable to attribute the dynamic nature of nursing requiring different levels of care for different patients, non-patient related work (Alghamdi, 2016; Halter *et al.*, 2017; Hayes *et al.*, 2012), and organisational factors as contributing to higher physical and mental workloads, emotional stress, and time pressure.

5.2.2.3. Chronic fatigue of the general sample

With reference to the chronic fatigue score, nurses were feeling moderately fatigued with a score of 28. This was consistent with previous research that has used the SSI than nurses in other studies (Korompeli *et al.*, 2013; McElroy *et al.*, 2020; Ruggerio, 2003; Saleh *et al.*, 2018).

Given that fatigue is multi-faceted and difficult to attribute to a particular issue, the degree of fatigue experienced by nurses in this cohort may be explained by some of the disadvantages that nurses reported such as having to work long hours that are tiring and strenuous. The combination of long hours, shorter sleep, moderate total sleep disturbance scores, higher sleep disturbance scores, mental and physical workloads on day shifts, and higher emotional stress and time pressure on night shifts in this sample of nurses may explain why nurses were experiencing moderate chronic fatigue. However, this likely needs further and more in-depth study in future research.

5.3. KEY FINDINGS FOR DIFFERNET SHIFT PATTERNS

5.3.1. Shift characteristics per shift type

Following data collection, it emerged that there were three distinct shift arrangements employed in the three healthcare facilities. These shift arrangements were categorised into three types of shifts: permanent night, rotating, and day shift, by cross referencing answers to “on average, how many nights do you work per year” and “how are these night shifts organised”.

Like the general sample, regardless of the shift arrangement, nurses work regular, 12-hour shifts with the same start and end times for shifts as stated for the general sample. Permanent night nurses work seven consecutive night shifts with seven days off, more than rotating nurses who work four to seven consecutive night shifts (Table 5) with two to three successive days off. The consecutive nights worked by permanent nurses, and consecutive days off are more than those captured in previous research (Seong *et al.*, 2021) who work two to four consecutive days, with a minimum of two days off. The differences in the way in which consecutive shifts for permanent night staff and rotating nurses working nights is unknown and should be explored further in future studies.

With regard to overtime hours, rotating nurses are working more paid, overtime hours per week than both permanent day and night shift nurses, whereas permanent night nurses work more unpaid overtime hours per week (Table 5). While not significant, permanent day shift nurses have more control of their shift systems overall compared with both rotating and permanent night shift nurses. Rotating nurses, however, had a significantly greater degree of unpredictability when required to change their roster on short notice (Figure 4) compared with permanent night and day staff. Furthermore,

rotating nurses had significantly more flexibility than permanent day shift nurses when requesting to work specific shifts (Figure 5). These two aspects of rostering may account for why rotating shift nurses may accumulated more overtime hours by being able to request to work more shifts especially when there is a shortage of and subsequent need for current nurses to work additional shifts, especially at night.

5.3.2. Sleep-wake behaviours between shift groups

5.3.2.1. Sleep duration

All shift nurses were sleeping less than the self-reported required sleep needed, with no significant differences between groups. While not significant, permanent night staff reported sleeping the shortest across all shift arrangements, and rotating shift nurses were sleeping for shorter periods on day shifts, relative to permanent day shift workers.

Permanent night shift nurses' sleep duration was similar to the sleep duration of one study (Chung *et al.*, 2011), longer than sleep durations in other studies (Geiger-Brown *et* al., 2012; Hirsch-Allen *et al.*, 2014; James *et al.*, 2020; Molzof *et al.*, 2019), and shorter than in four other studies (Dorrain *et al.,* 2006; Heath *et al.,* 2019; Seong *et al.,* 2022; Wilson *et al.,* 2019). This contrasts with some studies where sleep duration is less than six hours (Chung *et al.*, 2011; Hirsch-Allen *et al.*, 2014; James *et al.*, 2020; Molzof *et al.*, 2019).

While there are many reasons for this shortened sleep, it may be attributed to permanent night nurses waking up significantly earlier (between night shifts) than rotating nurses working night shifts. Although permanent night nurses are waking up significantly earlier than rotating nurses, no significant differences between permanent and rotating nurses were found for the question "Do you ever wake up earlier than intended?" Permanent night nurses are required to permanently sleep during the day on their duty days, making it difficult to obtain adequate sleep duration when biological inclined to be awake and alert during the day (Monk, 1989; Niu *et al.*, 2017). Additionally, permanent night nurses work more overtime hours than both rotating nurses and day shift nurses. More overtime may have contributed to shorter quick returns and subsequent shorter sleep post-night shift (Costa *et al.,* 2014; Vedaa *et al.,* 2015).

The sleep duration for permanent day nurses was similar to the results of the general sample working day shifts, and other studies where nurses are sleeping for seven

hours on average on day shifts (Wilson *et al.*, 2019) and seven to eight hours on days off (Hirsch-Allen *et al.*, 2014; James *et al.*, 2020; Molzof *et al.*, 2019). While this is at the lower end of what is recommended for adults, the ability to sleep during the biological night likely contributed to the reported sleep duration.

With respect to the rotating nurses, this study found that their sleep was longer on both day and night shifts compared with nurses in other studies that compared rotating nurses with fixed night and fixed day shift nurses (Chung *et al.*, 2011; Min *et al.*, 2021) which may have to do with the different contextual factors. In comparing the sleep duration for rotating and permanent day shift nurses, there was a lack of significant differences found which may be attributed to both groups of nurses having regular shift systems with the same start and end times, ultimately requiring both groups to wake up early for their shifts.

With reference to sleep duration on days off, all nurses reported sleeping more than the self-reported required amount, with rotating shift nurses reported sleeping for three hours more than permanent night and permanent day staff, sleeping significantly longer than permanent day nurses only. The difference in sleep duration between duty and off duty days is in line with previous literature (Dorrian *et al.*, 2011; James *et al.*, 2020; Madide 2003) and demonstrates that although total sleep did not differ between the three different shifts types (during duty day and night shifts) the nurses on rotating shifts may accumulated more sleep debt than the other groups given that they may have had to change their sleeping patterns following the shift rotation. This may have resulted in difficulties falling asleep following the change (due to circadian factors) which may have resulted in insufficient sleep and cumulative sleep debt. While not explored explicitly, the results for the sleep disturbance comparison support this hypothesis, but more research is necessary to fully understand the effects of the current shift rotation on nurse sleep.

5.3.2.2. Sleep Disturbance

Rotating shift nurses had higher total sleep disturbances (43) compared with permanent night (27.5) and permanent day shift nurses (32), although these findings were not statistically significant. Rotating shift nurses also had greater sleep disturbances on days off (17.5) compared with permanent night nurses (12.5). While no significant differences were found, rotating shift nurses experience greater

disturbances on night shifts than permanent night nurses, and experience greater sleep disturbances on day shifts than permanent day shift nurses. The total sleep disturbance score and score for day shifts for rotating nurses in this study was different to the findings of two studies (Ferri *et al.*, 2016; Korompeli *et al.*, 2013), where rotating nurses' sleep disturbance score was lower than those working day shifts.

There may be a number of reasons why sleep disturbances were higher in rotating shift workers compared to the permanent night and permanent day shift workers. While the speed and direction of rotation was not explored explicitly in this study, rotating shift nurses must constantly adapt their sleep-wake behaviours to both day and night work, which may result in circadian misalignment, subsequently negatively influencing sleep-wake behaviours (Costa, 2010; Deboer, 2018; Han *et al.*, 2014; Korompeli *et al.*, 2014). Day shift nurses work during natural circadian periods for wakefulness, therefore, do not need to adjust their circadian rhythms to work at night. Similarly, albeit for different reasons, sleep disturbance scores in the permanent night nurses may be due to the fact that over the seven consecutive nights they are required to work, they are able to adjust their sleep-wake cycles and experience some degree of entrainment important for sleep initiation and maintenance. Supported by two laboratory studies and one meta-analysis, is the fact that nurses working rotating shifts are unable to obtain good quality sleep or experience greater disturbances as they tolerate day and night shifts less by having to sleep and wake at different times according to which shifts they work (Chang & Peng, 2021; Korompeli *et al.*, 2013; Niu *et al.*, 2017). While not explored explicitly in this study, the irregularity in sleep and wake times may account for higher disturbances among rotating shift nurses. In addition, permanent night nurses may show less disturbances to their sleep-wake cycle attributed to nurses choosing to work night shifts (Barton 1994), which may enable them to plan their responsibilities and time for sleep according to their shift schedules, which is supported by previous research findings (Zion *et al.*, 2018). Being able to plan accordingly is consistent with permanent night nurses' advantages of their shift systems (Figure 8).

Another possible reason that may explain the sleep disturbance experienced by rotating nurses in this sample, is that rotating nurses had greater uncertainty around rostering than both permanent and night shift work, where nurses had to change their roster on short notice and were better able to work specific shifts. The more frequent

changes in roster, however, may be a contributing factor restricting the recovery time between shifts and the ability to adapt their sleep wake-behaviours accordingly.

Permanent night shift nurses reported receiving enough recovery time on their seven days off as an advantage of their shift system, allowing for adequate time for re-adjustment of their circadian rhythms and sleep-wake regulation. Adequate time for sleep on days among permanent night shift nurses may be the reason why they experienced less sleep disturbances than rotating nurses overall. Furthermore, when assessing the different aspects of sleep contributing to sleep disturbances, rotating nurses experience significantly poorer sleep quality than permanent night nurses (Table 13). Poorer sleep quality, in previous research, has been identified as a contributing factor to greater disturbances experienced by nurses, which may explain why rotating nurses are experiencing more disturbances to their sleep on their days off (Han *et al.*, 2014; Silva-Costa *et al.*, 2012). In addition, it is reasonable to infer that the higher degree of unpredictability of rotating shift systems, number of consecutive shifts worked, affecting adequate recovery between shifts, requires rotating nurses working night shifts to sleep longer on and off duty, due to experiencing greater disturbances to their sleep and poorer sleep quality.

5.3.2.3. Workload per shift group

Nurses working permanent day shifts reported greater physical and mental workloads than rotating nurses working day shifts, while having similar emotional and time pressures, although there were no significant differences found between the different shift arrangements. Comparing permanent night and rotating nurses working nights, rotating nurses experienced greater self-reported physical workload, emotional stress and time pressure, while permanent night nurses reported higher mental workloads. The lack of significant differences between the different shift nurses may be attributed to working during the COVID-19 pandemic where all nurses had high workloads in an unpredictable environment.

5.3.2.3. Chronic fatigue per shift group

While the findings were not significant between the three different groups, rotating nurses experienced higher levels chronic fatigue, followed by permanent day shift workers, with permanent night nurses feeling the least fatigued. The chronic fatigue score for rotating nurses in this sample was higher than what was found in one study (Ferri *et al.,* 2016), with a score of 26.3. It was expected that nurses working night

shifts, particularly permanent night nurses, would have greater chronic fatigue scores, in association with greater sleep disturbances (Saleh *et al.,* 2018), however no significant differences were found.

While not significant, the greater sleep disturbances observed for rotating shift nurses compared with the other two groups of nurses, and shorter sleep duration on day shifts may have an impact on the higher levels of chronic fatigue. With reference to workload variables, the higher workload variables observed among permanent day shift nurses compared with permanent night shift nurses in this sample, although not significant, may contribute to why permanent day shift nurses experience greater levels of fatigue.

5.4. EFFECT OF MEDIATING FACTORS

While it has been noted in previous research that individual factors play a role in the sleep-wake behaviours of nurses working shifts and tolerance to shift work (Costa, 2010), this was not the case in this study. After performing various statistical analyses no significant differences were found between the individual factors of those working day and night shifts within the general sample, as well as between nurses of different shift arrangements. These are discussed, for completeness sake, below.

5.4.5.1. Chronotype

While not significant for the general sample and nurses working in different shift arrangements, the chronotype scores indicated that nurses are mostly intermediate chronotypes, with more morning-types observed in nurses working day shifts, and no evening chronotypes. The higher number of intermediate chronotypes is a consistent finding in previous research (Hajaghazadeh *et al.*, 2019; Hittle & Gillespie, 2018; Saleh *et al.*, 2018). The lack of evening types observed, especially in the permanent night group was an interesting finding. While some studies say that evening types can tolerate night shifts better (Papatoniou *et al.,* 2015; Saksvik *et al.,* 2011), other research has noted that evening preference is associated with greater daytime sleepiness, poorer sleep quality and fatigue than intermediate and morning types (Hajaghazadeh *et al.*, 2019; Jung & Lee, 2015, Yazdi *et al.*, 2014). While not explored explicitly in this study, both arguments do not apply to the findings of this study to explain the influence of chronotype on sleep disturbances between day and night shifts for general sample, and across the different shift arrangements The influence of chronotype on nurses' sleep-wake behaviours and fatigue warrants further research.

5.5. IMPLICATIONS OF KEY FINDINGS

Considering that sleep is a restorative process, ample research suggests that acute sleep loss may have implications for alertness and performance (Dembe *et al.*, 2009; Geiger-Brown *et al.*, 2012; Gold *et al.*, 1992; Molzof *et al.*, 2019; Smith-Miller *et al.*, 2014) and health outcomes of nurses and the patients they treat, even though this was not explored in this study.

With reference to performance outcomes, shorter sleep duration and disturbances to sleep quality and quantity will negatively affect various cognitive process (related to alertness, memory attention levels and decision making) and mood which are necessary for the delivery of quality care (Dembe *et al.*, 2009; Geiger-Brown *et al.*, 2012; Seong *et al.*, 2021; & Wilson *et al.*, 2019). Decrements in cognitive processes increase the likelihood of charting, transcription, and medication errors affecting patient outcomes (Dembe *et al.*, 2009; Molzof *et al.*, 2019; Smith-Miller *et al.*, 2014). Apart from patient care, sleep- and fatigue-related reduced attention, especially with more consecutive shifts, increases the risk of needlestick injuries on shift (Smith-Miller *et al.*, 2014; Trinkoff *et al.*, 2007) and motor vehicle accidents post-shift (Molzof et al., 2019).

While shift is a necessary part of healthcare, there is ample research that has linked disruptive shifts schedules, sleep loss and circadian disruptions to various health ailments (Harrington, 2001; Kecklund & Axelsson, 2016; Moreno *et al.,* 2019). More research in the context of South Africa is necessary to continue to contribute to understanding the complex interactions between shift work and health. Regarding health, circadian stress resulting in physiological stress may alter hormone levels (Chen *et al.*, 2014; Korompeli *et al.* 2009). Altered physiological functions have been associated with irregular reproductive functions (Rosa *et al.*, 2019), increased risk of cardiovascular and gastrointestinal disorders, and certain cancers (Papantoniou *et al.*, 2015).

5.6. RESEARCH LIMITATIONS AND RECOMENDATIONS

This study had several limitations. Firstly, the data was collected during the COVID-19 pandemic, during the fourth wave in South Africa. This may have had several effects on the study including how this may affected nurses' willingness to participate outside of their existing workloads. Thus, despite actively trying to recruit nurses during

the data collection period, the sample size was relatively small, and as a result underpowered. A power analysis was not conducted in this study and should be explored in future studies to determine the statistical power of the differences are due to chance or the sample size.

Secondly, nurses complained of the length of the questionnaire and seemed less inclined to complete it, despite the researcher having carefully reduced the length of the version of the SSI used in this study compared to the full survey. Various senior nurses mentioned to the researcher that nurses were exhausted from documenting patient care throughout their shifts and that this resulted in nurses being tired of writing.

Since the private healthcare facilities being the primary COVID-19 treating private facilities in East London and in consultation with the nursing and hospital managers to reduce possible risk of COVID-19 infection by having too many nurses in close contact, the researcher was unable to host formal contact sessions with the nurses to aid them in navigating through the questionnaires. The researcher conducted brief information sessions with nursing managers and nurses at nursing stations at the beginning of data collection and during informal walkabouts during shift changes for nurses to answer any questions, however no issues were raised during these walkabouts. Although it was initially agreed by the gatekeeper and the researchers not to hold in-person sessions for the completion of the questionnaire, towards the end of data collection, 20-minute sessions were approved and held, but were poorly attended by the nursing staff.

The Standard Shiftwork Index is a self-report tool, which, while useful, may be affected by recall bias. It is recommended that a mixed methods approach be used for future studies, incorporating more objective measures such as actigraphy, subjective methods using sleep diaries, other validated sleep scales, the OFER scale for acute and chronic fatigue, and qualitative methods such as focus groups to discuss the shift systems and further explore the impact of shift arrangements on sleep-wake behaviours.

Furthermore, the survey being cross-sectional in nature, yielded data on the acute effects of shift work on sleep-wake behaviour. For future research a longitudinal study may be beneficial for more understanding of the sleep-wake behaviours of nurses. Furthermore, the speed and direction of rotating shift systems could not be adequately

assessed using the SSI, which is important in understanding the effect of rotating shifts on nurses' sleep-wake behaviours. It is therefore recommended that these two aspects of rotating shifts be investigated further.

The researcher's relationship with a senior manager at one of the healthcare facilities was a barrier to participation in the study. Nurses had voiced their concerns of participation and answers being repeated to or identified by management. Nurses shared that they were fearful of being reprimanded based on their answers, although participation remained anonymous and confidential in line with POPIA (2013). Nurses also shared that they were worried about sharing information regarding their shifts for fear of being reprimanded by nursing managers and thus were unwilling to participate, regardless of being assured that any information would be anonymous, would remain confidential, and would only be handled by the researcher.

The quality of the data (missing data) restricted the use of the multiple logistic regression recommended for the Standard Shiftwork Index using TIBCO Statistica. This played a role in choosing to use non-parametric tests such as the Mann-Whitney U and Kruskal Wallis to compare data between groups of nurses.

The findings of this study are context specific and not generalizable to public healthcare shift nurses in South Africa, or nurses in other private facilities with different shift systems. The effects of shift work on the sleep-wake behaviours and fatigue of shift nurses in public healthcare in South Africa should be explored.

Future research into the characteristics of shift work and sleep and fatigue could be used to develop effective sleep hygiene and fatigue management strategies to help nurses cope with working long hours. It may also be beneficial to compare the differences in sleep-wake behaviours and fatigue of nurses working in different wards of specialised care where workloads are patient-specific. In terms of the implications for nurses' performance, future studies should consider investigating the prevalence of shift work- and sleep-related accidents and incidences during shifts, paying particular attention to the role of fatigue. Moreover, future studies should investigate the influence of chronic diseases on the sleep-wake behaviours and fatigue of nurses. The influence of individual factors was not assessed in this study, but future research should consider exploring correlations between individual factors and shift-related changes in sleep-wake behaviours and fatigue. Additionally, future research should

consider the psychosocial factors both within and outside of the workplace, paying attention to the support of peers and supervisors and how these factors may influence stress and the quality of sleep of the nurses. The psychosocial factors may be important for future research into fatigue management strategies.

5.7. PRACTICAL RECCOMENDATIONS FOR THE HEALTHCARE FACILTIIES

This study shows that the unpredictability of rotating shift systems may negatively affects the sleep-wake behaviours and subsequent fatigue of rotating nurses on days off. It may therefore be beneficial to adopt a more predictable and permanent shift system for rotating nurses, so they are able to plan their daily activities on duty days to allow for more adequate time for sleep and reduce the disturbances experienced on days off associated when trying to “catch up on sleep”. This is provided that it is operationally possible and agreed to by the nursing staff who work these shifts.

To the researchers’ knowledge, there are no fatigue management strategies in place educating nurses on the effects of shift work on sleep and fatigue. It may be beneficial for the individual healthcare facilities or overall company, through a participatory approach, if sleep is a problem for nurses, and to explore the various fatigue management strategies to provide nurses with a comprehensive understanding of the effects of shift work. A fatigue management strategy and education programmes on the effect of shift work can be used to equip nurses with useful and necessary coping mechanisms to limit the adverse effects on nurses’ sleep-wake behaviours and possible negative performance outcomes.

CHAPTER VI
CONCLUSION AND RECOMMENDATIONS

The current study aimed to characterise nurses' shift arrangements and determine and elucidate the effects of these shifts on nurses' sleep-wake behaviours, namely sleep duration and disturbances, and fatigue. To date, to the best of the researcher's knowledge, this is one of the few studies using the Standard Shiftwork Index with nurses in private healthcare facilities in South Africa to characterise the shift systems worked and shift work's impact on nurses' sleep-wake behaviours and fatigue.

The current study, in line with previous research, irrespective of the type of shift being worked, on average, nurses reported receiving inadequate sleep, compared to their self-reported sleep need and the general recommendations. Nurses working night shifts, generally reported receiving less sleep than day shift nurses, with permanent night nurses sleeping the least between the different shift arrangements. This is likely attributed to a combination of those working night shifts having to sleep during a period of biological wakefulness, and those working day shifts waking up very early before their shifts. Furthermore, nurses working in a rotating shift system are experiencing greater self-reported disturbances to their sleep, especially on their days off, with higher sleep durations on off days indicating that nurses are trying to "catch up on" sleep. While the speed and direction of the rotation could not be accurately determined in this study, it may have perhaps been this rotation between day and night shifts The unpredictability of rotating nurse shift systems restricting the adequate adaption of sleep-wake cycles may be contributing to the greater sleep disturbances that they experience on their days off.

Based on the findings of this study, it is recommended that the healthcare facilities explore the various fatigue management strategies available to ensure that nurses understand and limit the impact of shift work on sleep. Furthermore, it may be beneficial to employ a more permanent and predictable rotating shift system to limit the sleep disturbances experienced by the rotating shift nurses. Recommendations for future research include taking a longitudinal approach to understand the chronic sleep-wake behaviours of nurses, whilst delving deeper in the speed and direction of rotating shift systems. Future research should adopt a mixed methods approach using both

subjective and objective perspectives to paint a more accurate picture shift nurses' sleep and fatigue.

These findings suggest that shift work, particularly the different shift arrangements employed by the three private healthcare facilities does negatively affect the sleep-wake behaviours of by nurses in private facilities, and that the sleep wake-behaviours of nurses working night shifts, especially nurses working in rotating shift systems. This adds to a large body of literature on the effects of shift work on nurses, but points to the need to continue to interrogate the effects of different shift system with the intention of trying to find the least disruptive schedule.

The Healthcare system continues to present numerous and complex challenges to those who work within, including the need for the provision of 24hour care. Considering that poor sleep and fatigue has and continues to contribute to various errors and detriments to staff and patient safety, it is imperative to explore the way shifts can be arranged to negate poor sleep and ensure that nurses can function as optimally as possible, no matter the time of day, to provide high quality care.

REFERENCES

Aaronson, L.S., Teel, C.S., Cassmeyer, V., Neuberger, G.B., Pallikkathayil, L., Pierce, J., Press, A.N., Williams, P.D., Wingate, A. (1999). Defining and measuring fatigue. *Journal of Nursing Scholarship, 31*(1), 45-50. https://doi.org/10.1111/j.1547-5069.1999.tb00420.x

Aeschbach, D., Matthews, J.R., Postolache, T.T., Jackson, M.A., GIesen, H.A., Wher, T.A. (1997). Dynamics of the human EEG during prolonged wakefulness: evidence for frequency specific circadian and homeostatic influences. *Neuroscience Letter, 239*, 121-124. https://doi.org/10.1016/S0304-3940(97)00904-X

Agostini, A., Centofanti, S.A., Colella, A., Devine, L., Dingle, C., Galindo, H., Pantelios, S., Brkic, G., Banks, S., & Dorrian, J. (2022). The relationships between coping styles and food intake in shiftworking nurses and midwives: A pilot study. *Industrial Health, 60*, 470-474. https://doi.org/10.2486/indhealth.2021-0091

Aikman, N. (2019). The crisis within the South African healthcare system: A multifactorial disorder. *South African Journal of Bioethics Law, 12*(2), 52-56. https://hdl.handle.net/10520/EJC-1c8f147c7f

Åkerstedt, T. (1988). Sleepiness as a consequence of shift work. *Sleep, 11*(1), 17-34. https://doi.org/10.1093/sleep/11.1.17

Åkerstedt, T., & Landström, U. (1998). Work place countermeasures of night shift fatigue. *International Journal of Industrial Ergonomics, 21*, 167-178. https://doi.org/10.1016/S0169-8141(97)00045-0

Åkerstedt, T., Knutsson, A., Westerholm, P., Theorell, T., Alfredsson, L., & Kecklund, G. (2002). Sleep disturbances, work stress and work ours: A cross-sectional study. *Journal of Psychosomatic Research, 53*, 741-748. https://doi.org/10.1016/S0022-3999(02)00333-1

Åkerstedt, T., & Wright, K.P Jr. (2009). Sleep loss and fatigue in shift work and shift work disorder. *Sleep Medicine Clinics, 4*(2), 257-271. https://doi.org/10.1016/j.jsmc.2009.03.001

Alegbeleye, B.J., Mohammed, R.K. (2020). Challenges of healthcare delivery in the context of COVID-19 pandemic in sub-Saharan Africa. *IBERO American Journal of Medicine, 2*(2), 100-109. http://dx.doi.org/10.5281/zenodo.3755414

Alenezi, A., McAndrew, S., & Fallon, P. (2019). Burning out physical and emotional fatigue: Evaluation the effects of a programme aimed at reducing burnout among mental health nurses. *International Journal of Mental Health Nursing, 28*, 1045-1055. https://doi.org/10.1111/inm.12608

Alghamdi, M.G. (2016). Nursing workload: A concept analysis. *Journal of Nursing Management, 24*(4), 449-457. Doi: 10.1111/jonm.12354

Allegranzi, B., Nejad, S.B., Combescure, C., Graafmans, W., Attar, H., Donaldson, L., & Pittet, D. (2011). The burden of endemic health-care-associated infection in developing countries: Systematic review and meta-analysis. *Lancet, 337*, 228-241. https://doi.org/10.1016/S0140-6736(10)61458-4

Alshahrani, S.M., Baqays, A.A., Alenazi, A.A., AlAngari, A.M., & AlHadi, A.N. (2017). Impact of shift work on sleep and daytime performance among health care professionals. *Saudi Medical Journal, 38*(8), 846-851. Doi:10.15537/smj.2017.8.19025.

Anand, S., & Bärninghausen T. (2012). Health workers at the core of the health system: Framework and research issues. *Health Policy, 105*, 185-191. https://doi.org/10.1016/j.healthpol.2011.10.012

Arendt,J. (2010). Shift work: Coping with the biological clock. *Occupational Medicine, 60*(10), 10-20. Doi: 10.1093/occmed/kqp162

Argent, A.C., Benbenishty, J., & Flaatten, H. (2015). Chronotypes, night shifts and intensive care. *Intensive Care Medicine, 41*(4), 698-700. Doi:10.1007/s00134-015-3711-7.

Arlinghaus, A., Bohle, P., Iskra-Golec, I., Jansen, N., Jay, S., & Rotenberg, L. (2019). Working time society consensus statements: Evidence-based effects of shift work and non-standard working hours on workers, family and community. *Industrial Health, 57*(2), 184-200. https://doi.org/10.2486/indhealth.SW-4

Armstrong, S.J., & Rispel, L.C. (2015). Social accountability and nursing education in South Africa. *Global Health Action*, *8* (s4), 1-9. Doi: 10.3402/gha.v8.27879

Aslani, F., & Bahmani, A. (2020). The role of stress of Covid-19 infection during work shifts, and nurses' emotional exhaustion under Covid-19 conditions. *Journal of Rehabilitation Sciences and Research, 9*(3), 118-122.

Atallah, L., Lo, B., & Yang, G. (2012). Can pervasive sensing address current challenges in global healthcare? *Journal of Epidemiology and Global Health, 2*(1), 1-13. https://doi.org/10.1016/j.jegh.2011.11.005

Bagheri Hosseinabadi, M., Ebrahimi, M., Khanjani, N., Biganeh, J., Mohammadi, S., Abdolafard, M. (2018). The effects of amplitude and stability of circadian rhythm and occupational stress on burnout syndrome and job dissatisfaction among irregular shift working nurses. *Journal of Clinical Nursing,* 28, 902-911. doi: 10.1111/jocn.14699

Ball, J., Day, T., Murrels, T., Dall'Ora, C., Rafferty, A.M., Griffiths, P., Maben, J. (2017). Cross-sectional examination of the association between shift length and hospital nurses job satisfaction and nurse reported quality measures. *British Medical Journal*, *16*(26), 1-7.

Bai, J.H., & Ravindran, V. (2020). Job stress among nurses. *Indian Journal of Continuing Nursing Education, 20*, 92-96.

Banakhar, M. (2017). The impact of 12-hour shifts on nurses' health, well-being, and job satisfaction: A systemic review. *Journal of Nursing Education and Practice*, *7*(11), 69-83.

Barger, L.K., Cade, B.E., Ayas, N.T., Cronin, J.W., Rosner, B., Speizer, F.E., & Cziesler, C.A. (2005). Extended work shifts and the risk of motor vehicle crashes among interns. *Journal of Medicine, 352*(2), 126-135.

Barker, L.M., & Nussbaum, M.A. (2011). Fatigue, performance, and the work environment: A survey of registered nurses. *Journal of Advanced Nursing, 67*(6), 1370-1382.

Barron, P., & Padarath, A. (2017). Twenty years of South African health: Review. In A. Padarath & P. Barron (Eds.), *South African Health Review 2017* (pp.1-8). Durban: Health Systems Trust. https://www.hst.org.za/publications/South%20African%20Health%20Reviews/HST%20SAHR%202017%20Web%20Version.pdf

Barton J. (1994). Choosing to work at night: A moderating influence on individual tolerance to shift work. *Journal of Applied Psychology, 79*(3), 449-454. https://psycnet.apa.org/doi/10.1037/0021-9010.79.3.449

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

Basu, D. (2018). Disease of public health importance in South Africa. *South African Journal of Public Health*, *2*(3), 48.

Basu, S., Andrews, J., Kishore, S., Panjabi, R., & Stuckler, D. (2012). Comparative performance of private and public healthcare systems in low- and middle-income countries: A systematic review. *PLoS Medicine*, *9*(6), e1001244. Doi:10.1371/journal.pmed.1001244

Batak, T., Gvozdenović, L., Bokan, D., Bokan, D. (2013). The impact of nurses' shift work on the fatigue level. *South Eastern Europe Health Sciences Journal (SEEHSJ), 3*(2), 120-127.

Berendes, S., Heywood, P., Oliver, S., & Garner, P. (2011). Quality of private and public ambulatory health care in low and middle income countries: Systematic review of comparative studies. *PLoS Medicine, 8*(4), 1000433. Doi:10.1371/journal.pmed.1000433

Bekker, M., Coetzee, S.K., Klopper, H.C., & Ellis, S.M. (2015). Non-nursing tasks, nursing tasks left undone and job satisfaction among professional nurses in South African hospitals. *Journal of Nursing Management, 23*(8), 1115-1125. https://doi.org/10.1111/jonm.12261

Berger, P.J., McCutcheon, L., Soust, M., Walker, A.M., & Wilkinson, M.H. (1991). Electromyographic changes in the isolated rat diaphragm during the development of fatigue. *European Journal of Applied Physiology, 62*, 310-316.

Bjorvatn, B., Stangenes, K., Øyane, N., Forberg, K., Lowden, A., Holsten, F., & Åkerstedt, T. (2006). Subjective and Objective Measures of Adaption and Readaption to Night Work on an Oil Rig in the North Sea. *Sleep,* 29(6), 821-829.

Blaauw, D., Ditlopo, P., Maseko, F., Chirwa, M., Mwisongo, A., Bidwell, P., Thomas, S., & Normand, C. (2013). Comparing job satisfaction and intention to leave of different categories of health workers in Tanzania, Malawi, and South Africa. *Global Health Action, 6*(1), 127-137. https://doi.org/10.3402/gha.v6i0.19287

Bogossian, F., Winters-Chang, P., & Tuckett, A. (2014). "The pure hard slog that nursing is…": A qualitative analysis of nursing work. *Journal of Nursing Scholarship, 46*(5), 377-388.

Borbély, A.A. (1982). A two process model of sleep regulation. *Human Neurobiology, 1*(3), 195-204.

Borbély, A.A., & Acherman, P. (1999). Sleep homeostasis and models of sleep regulation. *Journal of Biological Rhythms, 14*(6), 559-568.

Borbély, A.A., Daan, S., Wirz-Justice, A., & Deboer, T. (2016). The two-process model of sleep regulation: A reappraisal. *Journal of Sleep Research, 25*(2), 131-143.

Braithwaite, J., Churruca, K., Ellis, L.A., Long, J., Clay-Williams, R., Damen, N., Herkes, J., Pomare, C., & Ludlow., K. (2017). *Complexity science in healthcare: Aspirations, approaches, application and accomplishments: A white paper*. Sydney: Australia Institute of Health Innovation, Macquarie University. https://www.mq.edu.au/research/research-centres-groups-and-facilities/healthy-people/centres/australian-institute-of-health-innovation/news-and-events/news/news/complexity-science-in-healthcare-aspirations,-approaches,-applications-and-accomplishments-a-white-paper

Braun, V., & Clarke, V. (2012). Thematic analysis. In H. Cooper, P.M. Camic, D.L. Long, A.T. Panter, D. Rindskopf, & K.J. Sher (Eds.), *APA handbook for*

research methods in psychology, Vol. 2 Research designs: Quantitative, qualitative, neuropsychological, and biological (pp 57-71). American Psychological Association. Doi: 10.1037/13620-004

Brennan, C.W., & Daly, B.J. (2008). Patient acuity: A concept analysis. *Journal of Advanced nursing, 65*(5), 1114-1126. Doi:10.1111/j.1365-2648.2008.04920.x

Brucker, P., Burke, E.K., Curtois, T., Qu, R., Vanden Berghe, G. (2009). A shift sequence based approach for nurse scheduling and a new benchmark dataset. *Journal of Heuristics,*16(4), 559-573. Doi: 10.1007//s10732-008-9099-6.

Buchvold, H.V., Pallesen, S., Øyane, N.M.F., & Bjorvatn, B. (2015). Associations between night work and BMI, alcohol, smoking, caffeine, and exercise – a cross sectional study. *BMC Public Health, 15*(1112), 1-8. Doi: 10.1186/s12889-015-2470-2

Burdelak, W., Bukowska, A., Krysicka, J., & Peptońska, B. (2012). Night work and health status of nurses and midwives. *Medycyna Pracy, 63*(5), 517-529.

Burgess, H.J., & Eastman, C.I. (2004). Early versus late bedtimes phase shift the human dim light melatonin rhythm despite a fixed morning lights on time. *Neuroscience Letters*, *356*(2), 115-118.

Buysse, D.J. (2014). Sleep health: Can we define It? Does it matter? *Sleep,* 37(1), 9-17. Doi: 10.5665/sleep.3298

Buysse, D.J., Reynolds, C.F., Monk, T.H., Berman, S.R., & Kupfer, D.J. (1988). The Pittsburgh Sleep Quality Index: A new instrument for psychiatric practice and research. *Psychiatric Research, 28*(2), 193-213. Doi: 10.1016/0165-1781(89)90047-4

Cajochen, C., Kräuchi, K., Wirz-Justice, A. (2003). Role of melatonin in the regulation of human circadian rhythms and sleep. *Journal of Neuroendocrinology, 15*(4), 432-437.

Caldwell, J.A., Caldwell, J.L., Thompson, L.A., & Lieberman, H.R. (2019). Fatigue and its management in the workplace. *Neuroscience and Behavioural Reviews, 96*, 272-289.

Carayon, P. (2006). Human factors and ergonomics in healthcare and patient safety. In P. Carayon (Ed.), *Handbook of human factors and ergonomics in healthcare and patient safety* (2nd ed., pp.3-15). Taylor Francis Group.

Carayon, P., & Gurses, A.P. (2008). Nursing workload and patient safety – A human factors and engineering perspective. In R.G. Hughes (Ed.), *Patient safety and quality: An evidence-based handbook for nurses* (Chapter 30). Rockville (MD): Agency for Healthcare Research Quality. https://www.ncbi.nlm.nih.gov/books/NBK2657/

Carrier, J. (2014). The role of sleep and circadian rhythms in health: a snapshot of key interrogations. *Pathologie Biologie, 62*, 231-232.

Carrier, J., Monk, T.H., Buysse, D.J., & Kupfer, D.J. (1997). Sleep and morningness-eveningness in the 'middle' years of life (20-59y). *Journal of Sleep Research, 6*(4), 230-237.

Carskadon, M.A., & Dement, W.C. (2011). Normal human sleep: An overview. In M.H. Kryger, T. Roth, & W.C. Dement (Eds.), *Principles and practice of sleep medicine* (5th ed., pp.16-26). Elsevier. https://doi.org/10.1016/C2009-0-59875-3

Carskadon, M.A., Vieira, C., & Acebo, C. (1993). Association between puberty and delayed phase preference. *Sleep, 16*(3), 258-262.

Carter, C. (2019). *Critical care nursing in resource limited environments*. New York: Routledge.

Catton, H. (2020). Global challenges in health and healthcare for nurses and midwives everywhere. *International Nursing Review, 67*(1), 4-6.

Caruso,C.C. (2014). Negative impacts of shiftwork and long work hours. *Rehabilitation Nursing*, *39*(1), 16-25.

Caruso C.C., & Hitchcock, E. (2010). Strategies for nurses to prevent sleep-related injuries and errors. *Rehabilitation Nursing,* 35(5), 192-197.

Caruso, C.C., Lusk, S.L., & Gillespie, B.W. (2004). Relationship of work schedules to gastrointestinal diagnoses, symptoms, and medication use in auto factory workers. *American Journal of Industrial Medicine, 46*, 586-598.

Centofanti, S., Banks, S, Colella, A., Dingle, C., Devine, L., Galindo, H., Pantelios, S., Brkic, G., & Dorrian, J. (2018). Coping with shift-related circadian disruption: A mixed-methods care study on napping and caffeine use in Australian nurses and midwives. *Chronobiology International, 35*(6), 853-864.

Chabikuli, N., Blaauw, D., Gilson, L, & Scheider, H. (2005). Human resource policies sector reform and the management of PHC services in South Africa: Human resources. *South Africa Health Review, 2005(1),* 104-114. https://journals.co.za/toc/healthr/2005/1

Chan, M.F. (2008). Factors associated with perceived sleep quality of nurses working on rotating shifts. *Journal of Clinical Nursing, 18*, 285-293. Doi:10.1111/j.1365-2702.2008.02583.x

Chang, W., & Peng, Y. (2021). Meta-analysis of differences in sleep quality based on actigraphs based on actigraphs between day and night shift workers and the moderating effect of age. *Journal of Occupational Health, 63*(1), e12262, 1-12. Doi: 10.1002/1348-9585.12262

Chaput, J., Dutil, C., & Sampasa-Khanyinga, H. (2018). Sleeping hours: What is the ideal number and how does age impact this? *Nature and Science of Sleep, 10*, 421-430.

Chaput, J., Dutil, C., Featherstone, R., Ross, R., Giangregorio, L., Saunders, T.J., Janssen, I., Poitras, V.J., Kho, M.E., Ross-White, A., Zankar, S., & Carrier, J. (2020) Sleep timing, sleep consistency, and health in adults. *Applied Physiology and Nutrition, 45*, S232-S247. Doi:10.1139/apnm-2020-0032

Chen, J., Daraiseh, N.M., Davis, K.G., & Pan, W. (2014). Sources of work-related acute fatigue in United States hospital nurses. *Nursing and Health Sciences, 16*, 19-25.

Chen, J., Davis, K.G., Daraiseh, N.M., Pan, W., & Davis, L.S. (2014). Fatigue and recovery in 12-hour dayshift hospital nurses. *Journal of Nursing Management, 22*, 593-603.

Chopra, M., Lawn, J.E., Sanders, D., Barron, P., Abdool Karim, S.S., Bradshaw, D., Jewekes, R., Abdool Karim, Q., Flisher, A.J., Mayosi, B.M., Tollman, S.M.,

Churchyard, G.J., & Coovadia, H. (2009). Achieving the health millennium development goals for South Africa: Challenges and priorities. *Lancet*, *347*, 1023-1031.

Chung, M., Chang, F., Yang, C.C.H. Kuo, T.B.J., & Hsu, N. (2007). Sleep quality and morningess-evening of shift nurses. *Journal of Clinical Nursing, 18*, 279-284. doi: 10.1111/j.1365-2702.2007.02160.x

Chung, M., Kuo, T.B.J., Chu, H., Chou, K., & Yang, C. (2009). Sleep and autonomic nervous system changes – enhanced cardiac sympathetic modulations during sleep in permanent night shift nurses. *Scandinavian Journal of Environmental Health, 35*(3), 180-187. Doi: 10.5271/sjweh.1324

Chung, M., Liu, W., Lee, H., & Hsu, N. (2013). Selected neurophysiological, psychological, and behavioural influences on subjective sleep quality in nurses: A structure equation model. *PLoS ONE, 8*(11), e79529. https://doi.org/10.1371/journal.pone.0079529

Chung, M. H., & Yang, C. C. (2011). Heart rate variability across the menstrual cycle in shift work nurses. *Journal of Experimental & Clinical Medicine, 3*(3), 121-125.

Coetzee, S.K., Klopper, H.C., Ellis, S.M., & Aiken, L.H. (2013). A tale of two systems – Nurses practice environment, well-being, perceived quality of care and patient safety and public hospital in South Africa: A questionnaire survey. *International Journal of Nursing Studies, 50*, 162-173.

Coovadia, H., Jewkes, R., Barron, P., Sanders, D., & McIntyre, D. (2009). The health and health system of South Africa: Historical roots of current public health challenges. *The Lancet,* 374(9692), 817-834. https://doi.org/10.1016/S0140-6736(09)60951-X

Copertaro, A., Bracci, M., Gesuita, R., Carle, F., Amati, M., Baldassari, M., Mocchengiani, E., & Santaerrli, L. (2011). Influence of shift-work on selected immune variables in nurses. *Industrial Health, 49*, 597-604.

Cormier, R.E. (1990). Sleep disturbances. In H.K. Walker, W.D. Hall, & J.W. Hurst (Eds.), *Clinical methods: The history, physical, and laboratory examinations* (3rd

ed., Chapter 77). Butterworth Publishers. https://pubmed.ncbi.nlm.nih.gov/21250045/

Costa, G. (2003). Shift work and occupational medicine: an overview. *Occupational Medicine,* 53(20), 83-88.

Costa, G. (2010). Shift work and health: Current problem and preventative actions. *Safety Health Work, 1*, 112-123.

Costa, G. (2016). Introduction to problems of shift work. In I. Iskra-Golec, J. Barness-Farrell, & P. Bohle (Eds.), *Social and family issues in shift work and non standard working hours* (pp. 19-35). New York: Springer Publishers. https://doi.org/10.1007/978-3-319-42286-2_2

Costa, G., Anelli, M.M., Castellini, G., Fustinoni, S., & Neri, L. (2014). Stress and sleep in nurses employed in “3 x 8” and “2 x 12” fast rotating shift schedules. *Chronobiology International, 31*(10), 1169-1178.

Costa, G., Tommasi, E., Giovannini, L., & Mucci, N. (2021). Shiftwork organization. In L. Donaldson, W. Ricciardi, S. Sheridan, & R. Tartaglia (Eds.), *Textbook of patient safety and clinical risk management* (pp. 403-411). Cham: Springer Nature Switzerland AG.

Courtney, J.A., Francis, A.J., & Paxton, S.J. (2013). Caring for the country: Fatigue, sleep, and mental health in Australian rural paramedic shiftworkers. *Journal of Community Health, 38*,178-186.

Cronk, R., & Bartram, J. (2018). Environmental conditions in health care facilities in low-and middle-income countries: Coverage and inequalities. *International Journal of Hygiene and Environmental Health, 221*, 409-422. Doi:10.1016/j.ijheh.2018.01.004

Crowly, S.J., Acebo, C., & Carskadon, M.A. (2007). Sleep, circadian rhythms, and delayed phase in adolescents. *Sleep Medicine, 8*, 602-612.

Czeisler, C.A., & Gooley, J.J. (2007). Sleep and circadian rhythms in humans. *Cold Spring Harbor Symposia on Quantitative Biology, 72*, 579-597.

Czeisler, C.A., Weitzman, E.D., Moore-Ede, M.C., Zimmerman, J.C., & Knauer, R.S. (1980). Human sleep: Its duration and organization depend on its circadian phase. *American Association for the Advancement of Science, 210*, 1264-1267.

Da Silva, A.L. (2008). Nursing in the era of globalization: challenges for the 21st century. *Revista Latino-am Enfermagem, 16*(4), 787-790.

Dahlgran, A., Tucker, P., Gustavsson, P., & Rudman, A. (2016). Quick returns and night work as predictors of sleep quality, fatigue, work-family balance and satisfaction with work hours. *Chonobiology International, 33*(6), 759-767. doi:10.3109/07420528.2016.1167725.

Dall'Ora, C., Ball, J., Recio-Saucedo, A., & Griffiths, P. (2016). Characteristics of shift work and their impact on employee performance and wellbeing: A literature review. *International Journal of Nursing Studies, 57*, 12-27.

Dall'Ora, C., Ball, J., Reinius, M., & Griffiths, P. (2020). Burnout in nursing: A theoretical review. *Human Resources for Health, 18*(41), 1-17. Doi:10.1186/s12960-020-00469-9

Dall'Ora, C., Ejebo, O.Z., & Griffiths, P. (2022). Because they're worth it? A discussion paper on the value of 12-h shifts for hospital nursing. *Human Resources for Health, 20*(36), 1-7. https://doi.org/10.1186/s12960-022-00731-2

Deboer, T. (2018). Sleep homeostasis and the circadian clock: Do the circadian pacemaker and the sleep homeostat influence each other's functioning? *Neurobiology of Sleep and Circadian Rhythms, 5*, 68-77.

Deboer, T., Détári, L., & Meijer, J.H. (2007). Long term effects of sleep deprivation on the mammalian circadian pacemaker. *Journal of Sleep*, *30*(3), 1.

Dembe, A.E., Delbos, R., & Erickson, J.B. (2009). Estimates of injury risk for healthcare personnel working night shift and long hours. *Quality Staff Health Care, 18*, 336-340.

Dement, W.C., & Carskadon, M.A. (1982). Current perspectives on daytime sleepiness: The issues. *Sleep, 5*(2), S56-S66.

Desjardins, S., Lapierre, S., Hudon, C., & Desgagné, A. (2019). Factors involved in sleep efficiency: A population-based study of community-dwelling elderly persons. *Sleep, 42*(5), 1-10. https://doi.org/10.1093/sleep/zsz038

De Villiers, K. (2021). Bridging the health inequality gap: an examination of South Africa's social innovation in health landscape. *Infectious Diseases of Poverty, 10*(19), 1-7.

Didikoglu, A., Maharani, A., Tampubolon, G., Canal, M.M., Payton, A., & Pendleton, N. (2019). Longitudinal sleep efficiency in the elderly and its association with health. *Journal of Sleep Research*, *29*(3), e12898, 1-11. Doi:10.1111/jsr12898.

Djik, D-J. Duffy, J.F., Riel, E., Shanahan, T.L, & Czeisler, C.A. (1999). Aging and the circadian and homeostatic regulation of human sleep during forced desynchrony of rest, melatonin and temperature rhythms. *Journal of Physiology, 516*(2), 611-627.

Dijk, D-J., Duffy, J.F., Silva, E.J., Shanahan, T.L., Boivin, D.B., & Czeisler, C.A. (2012). Amplitude reduction and phase shifts of melatonin, cortisol and other circadian rhythms after a gradual advance of sleep and light exposure in humans. *PLoS ONE,* 7(2), e30037. Doi:10.1371/journal.pone.0030037.

Donley, R. (2005). Challenges for nursing in the 21st century. *Nursing Economics, 23*(6), 312.

Dorrian, J., Baulk, S.D., & Dawson, D. (2011). Work hours, workload, sleep and fatigue in Australian Rail Industry employees. *Applied Ergonomics, 42*(2), 202-209.

Dorrian, J., Heath, G., Sargent, C., Banks, S., & Coates, A. (2017). Alcohol use in shiftworkers. *Accident Analysis and Prevention, 99*, 395-400. Doi:10.1016/j.aap.2015.11.011

Dorrian, J., Paterson, J., Dawson, D., Pincombe, J., Grech, C., & Rogers, A.E. (2011). Sleep, stress and compensatory behaviours in Australian nurses and midwives. *Revista Saúdi Pública, 45*(5), 922-930.

Drennan, V.M., & Ross, F. (2019). Global nursing shortages – the facts, the impact and action for changes. *British Medical Bulletin, 130*(1), 25-37.

Duffy, J.F., Wilson, H.J., Wang, W., & Czseisler, C.A. (2009). Healthy older adults better tolerate sleep deprivation than young adults. *Journal of American Geriatrics Society, 57*, 1245-1251. Doi: 10.1111/j.1532-5415.2009.02303.x

Edéll-Gustafsson, U.M. (2002). Sleep quality and responses to insufficient sleep in women on different work shifts. *Journal of Clinical Nursing, 11*, 280-288.

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), e70882. Doi: 10.1371/journal.pone.0070882

Engelbrecht, M., Rau, A., Nel, P., & Wilke, M. (2020). Emotional well-being and work engagement of nurses who moonlight (dual employment) in private hospitals. *International Journal of Nursing Practice, 26*(1), e12783. Doi: 10.1111/ijn.12783

Farag, A., Scott, L., Perkhounkova, Y., & Hein, M. (2022). A human factors approach to evaluate predictors of acute care nurse occupational fatigue. *Applied Ergonomics*, *100* (103647), 1-10. Doi: 10.1016/j.apergo.2021.103647

Faraut, B, Cordina-Duverger, E., Aristizabal, G., Drogou, C., Gauriau, C., Sauvet, F., Lévi, F., Léger, D., & Guénel, P. (2022). Immune disruptions and night shift work in hospital healthcare professionals: The intricate effects of social jet-lag and sleep debt. *Frontiers in Immunology, 13*(939829). DOI 10.3389/fimmu.2022.939829

Ferguson, S.A., & Dawson, D. (2012). 12-h or 8-h shifts? It depends. *Journal of Sleep Medicine Reviews, 16*, 519-528.

Ferreira, L.R.C., & De Martino, M.M.F. (2012). Sleep patterns and fatigue in nursing students who work. *Revista de Escolae Enfermagem da USP, 46*(5), 1176-1181.

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 night shifts and day shifts. *Risk Management and Healthcare Policy, 9*, 203-211.

Fischer, D., Lombardi, D., Marucci-Wellman, H., Roenneberg, T. (2017). Chronotypes in the US – Influence of age and sex. *PLoS ONE, 12*(6), 1-17. doi: 10.1371/journal.pone.0178782

Fitzpatrick, J.M., While, A.E., & Roberts, J.D. (1999). Shift work and its impact upon nurse performance: current knowledge and research issues. *Journal of Advanced Nursing, 29*(1), 18-27.

Flo, E., Pallesan, S., Åkerstedt, T., Magerøy, N., Moen, B.E., Grønli, J., Nordhus, I.H., & Bjorvatn, B. (2013). Shift-related sleep problems vary according to work schedule. *Occupational & Environmental Medicine, 70*, 238-245.

Folkard, S., & Åkerstedt, T. (2004). Trends in the risk of accidents and injuries and their implication for models of fatigue and performance. *Aviation, Space, and Environmental Medicine, 75*(3, Suppl.A), 161-167.

Folkard, S., & Lombardi, D.A. (2006). Modeling the impact of the components of long work hours on injuries and "accidents". *American Journal of Industrial Medicine, 49*, 953-963.

Futema, K., Asaoka, S., Takaesu, Y., Komada, Y., Ishikawa, I., Murakoshi, A., Nishida, S., & Inoue, Y. (2015). Impact of hypnotics use on daytime function and factors associated with usage by female shift workers. *Sleep Medicine, 16*, 604-611. Doi: 10.1016/j.sleep.2014.11.018

Gander, P., O'Keeffe, K., Santos-Fernandez, E., Huntington, A., Walker, L., & Wills, J. (2019). Fatigue and nurses' work patterns: An online questionnaire survey. *International Journal of Nursing Studies, 98*, 67-74. https://doi.org/10.1016/j.ijnurstu.2019.06.011

Ganesan, S., Magee, M., Stone, J.E., Mulhall, M.D., Collins, A., Howard, M.E., Lockley, S.W., Rajaratnam, S.M.W., & Sletten, T.L. (2019). The impact of shift work on sleep, alertness and performance in healthcare workers. *Scientific Reports, 9*(4635), 1-13.

Gao, X., Jiang, L., Hu, Y., Li, L., & Hou, L. (2020). Nurses' experiences regarding shift patterns in isolation wards during the COVID-19 pandemic in China: A qualitative study. *Journal of Clinical Nursing, 29*, 4270-4280.

Garde, A., Harris, A., Vedaa, *Ø*, Bjorvatn, B., Hansen, Å., Kolstad, H., Koskinen, A., Pallesen, S., Ropponen, A., & Härmä, M. (2019). Working hour characteristics and schedules among nurses in three Nordic countries. *BMC Nursing, 18*(12), 1-10. Doi: 10/1186/s12912-019-0332-4

Geiger-Brown, J., Rogers, V.E., Trinkoff, A.M., Kane, R.L., Bausell, B., & Scharf, S.M. (2012). Sleep, sleepiness, fatigue, and performance of 12-hour-shift nurses. *Chronobiology International, 29*(2), 211-219. Doi: 10.3109/07420528.2011.645752.

Geiger-Brown, J., & Trinkoff, A. (2010). Is it time to pull the plug on 12-hour shifts? *Journal of Nursing Administration, 40*(3), 100-102.

Gifkins, J., Johnston, A., Loudoun, R., & Troth, A. (2020). Fatigue and recovery in shiftworking nurses: A scoping literature review. *International Journal of Nursing Studies, 112*(103710), 1-15.

Giorgi, F., Mattei, A., Nortanicola, I., Petrucci, C., & Lancia, L. (2017). Can sleep quality and burnout affect the job performance of shift-work nurses? A hospital cross-sectional study. *Journal of Advanced Nursing, 74*, 698-708.

Goel, N., Bassner, M., Rao, H., & Dinges, D.F. (2013). Circadian rhythms, sleep deprivation, and human performance. *Progress in Molecular Biological and Translational Science, 119*, 155-190.

Gold, D.R., Rogadz, S., Bock, N., Tosteson, T.D., Baum, T.M., Spiezer, F.E., & Czeisler, C.A. (1992). Rotating shift work, sleep, and accidents related to sleepiness in hospital nurses. *American Journal of Public Health, 82*, 1011-1014.

Grech, M., Neal, A., Yeo, G., Humphreys, M., Smith, S. (2009). Workload and fatigue: an examination of the relationship within and across consecutive days of work. *Journal of Occupational Health and Psychology,* 14(3), 231-242.

Griffiths, P., Dall'Ora, C., Simon, M., Ball, J., Lindqivs, R., Rafferty, A., Schoonhoven, L., Tishelman, C., & Aiken, L.H. (2014). Nurses' shift length and overtime working in 12 European countries: The association with perceived quality of care and patient safety. *Medical Care, 52*(11), 975-981.

Hajaghazedeh, M., Zamanzadeh, V., Ghofrani, M., & Orujlu, S. (2019). Morningness-eveningness chronotypes, sleep quality and sleepiness among nurses. *The Open Public Health Journal, 12*, 414-410. Doi: 10.2174/187494450192010414

Haldar, P., & Sahu, S. (2015). Occupational stress and work efficiency of nursing staff engaged in rotating shift work. *Biological Rhythm Research, 46*(4), 511-522. Doi: 10.1080/09291016.2015.1021153.

Halter, M., Boiko, O., Pelone, F., Beighton, C., Harris, R., Gale, J., Gourlay, S., & Drennan, V. (2017). The determinants and consequences of adult nursing staff turnover: a systematic review of systematic reviews. *BMC Health Services Research, 17*(824), 1-20. Doi:10.1186/s12913-017-2707-0

Haluza, D., Schmidt, V., & Blasche, G. (2018). Time course of recovery after two successive night shifts: A diary study among Australian nurses. *Journal of Nursing Management, 27*, 190-196. Doi: 10.1111/jpnm.12664.

Han, K., Trinkoff, A.M., & Gierger-Brown, J. (2014). Factors associated with work-related fatigue and recovery in hospital nurses working 12-hour shifts. *Workplace Health and Safety, 62*(10), 409-414.

Harrington, J.M. (2001). Health effects of shift work and extended hours of work. *Occupational and Environmental Medicine*, *58*, 68-72.

Harris, R., Sims, S., Parr, J., & Davies, N. (2015). Impact of 12 h shift patterns in nursing: A scoping review. *International Journal of Nursing Studies, 52*, 605-634. Doi:10.1016/j.jnurstu.2014.10.014

Hayes, L.J., O'Brien-Pallas, L., Duffield, C., Shamian, J., Buchan, J., Hughes, F., Laschinger, H.K.S., & North, N. (2012). Nurse turnover: A literature review – an update. *International Journal of Nursing Studies, 49*, 887-905.

Heath, G, Dorrian, J., & Coates, A. (2019). Associations between shift type, sleep, mood, and diet in a group of shift-working nurses. *Scandinavian Journal of Work and Environmental Health, 45*(4), 402-412. Doi: 10.5271/sjweh.3803

Hignett, S., Carayon, P., Buckle, P., & Catchpole, K. (2013). State of science: Human factors and ergonomics in healthcare. *Ergonomics, 55*(10), 1491-1503.

Hirotsu, C., Tufik, S., & Anderson, M.L. (2015). Interactions between sleep, stress, and metabolism: from physiological to pathological conditions. *Sleep Science, 8*, 143-152.

Hirsch-Allen, A.J., Park, J.E., Adhami, N., Sirounis, D., Tholin, H., Dodek, P., Rogers, A.E., & Ayas, N. (2014). Impact of work schedules on sleep duration of critical care nurses. *American Journal of Critical Care, 23*(4), 290-295. Doi: 10.4037/ajcc2014876

Hirschkowitz, M., Whiton, K., Albert, S.M., Alessi, C., Bruni, O., DonCarlos, L., Hazen, N., Herman, J., Katz, E.S., Kheirandish-Gozal, L., Naubauer, D.N., O'Donnell, Ohayon, M., Peever, J., Rawding, R., Sachdeva, R.C., Setters, B., Vitiello, M.V., Ware, J.C., & Hillard, P.J.A. (2015). National Sleep Foundation's sleep

time duration recommendations: Methodology and result summary. *Sleep Health*, *1*, 40-43. Doi:10.1016/j.sleh.2014.12.010

Hittle, B.M., Caruso, C.C., Jones, H.J., Bhattacharya, A., Lambert, J., & Gillespie, L. (2020). Nurse health: The influence of chronotype and shift timing. *Western Journal of Nursing Research, 42*(12), 1031-1041. Doi: 10.117/0193945920916802

Hittle, B.M., & Gillespie, G.L. (2018). Identifying shift worker chronotype: implication for health. *Industrial Health, 56*, 512-523.

Hlafe, B., Sibanda, K., & Hompashe, D.M. (2019). The impact of public health expenditure on health outcomes in South Africa. *International Journal of Environmental Research and Public Health, 16*(16), 2993.

Huttinger, A., Dreibelbis, R., Kayigamba, F., Ngabo, F., Mfura, L., Merryweather, B., Cardon, A., & Moe, C. (2017). Water, sanitation and hygiene infrastructure and quality in rural healthcare facilities in Rwanda. *BMC Health Services Research, 17*(517), 1-11. Doi:10.1186/s12913-017-2460-4

Imes, C.C., Barthel, N.J., Chasens, E.R., Dunbar-Jacob, J., Engberg, S.J., Feeley, C.A., Fennimore, L.A., Godzik, C.M., Klem, M.L., Luyster, F., Ren, D., & Baniak, L. (2023). Shift work organization on nurse injuries: A scoping review. *International Journal of Nursing Studies, 138*(104395), 1-9. Doi: 10.1016/j.inurstu2022.104395

Institute of Medicine (US) Committee on Sleep Medicine and Research. (2001). *Crossing the quality chasm: A new health system for the 21st century*. Washington, DC: National Academy Press. https://doi.org/10.17226/10027

Institute of Medicine (US) Committee on Sleep Medicine and Research. (2006). Sleep physiology. In H.R. Colten & B.M. Altevogt (Eds.), *Sleep disorders and sleep deprivation: An unmet public health problem* (pp. 33-54). Washington DC: National Academies Press (US). https://pubmed.ncbi.nlm.nih.gov/20669438/

International Labour Organisation. (1987). *Safety-health and working conditions*. *Training manual*. Sweden: Joint Industrial Safety Council. https://www.ilo.org/global/topics/safety-and-health-at-work/resources-library/training/WCMS_175900/lang--en/index.htm

International Labour Organisation. (2004). *Shift work. Information Sheet No. WT-8.* Geneva, Switzerland: International Labour Office. https://www.ilo.org/travail/info/fs/WCMS_170713/lang--en/index.htm

International Labour Organisation. (2011). *Working time in the twenty-first century: Conditions of work and employment programme*. Geneva, Switzerland: International Labour Office. https://www.ilo.org/travail/info/publications/WCMS_161734/lang--en/index.htm

International Labour Organisation. (2016). *Non-standard employment around the world: Understanding challenges, shaping prospects*. *Geneva,* Switzerland: International Labour Office. https://www.ilo.org/caribbean/information-resources/WCMS_534326/lang--en/index.htm

International Labour Organisation. (2019). *Guide to developing balanced working time arrangements*. Genevan, Switzerland: International Labour Office. https://www.ilo.org/travail/info/publications/WCMS_706159/lang--en/index.htm

James, L., James, S.M., Wilson, M., Brown, N., Dotson, E., Edwards, C.D., & Butterfield, P. (2020). Sleep health and predicted cognitive effectives of nurses working 12-hour shifts: An observational study. *International Journal of Nursing Studies*, *112*, 103667. doi:10.1016/j.ojnurstu2020.103667.

James, L., Elkins-Brown, N., Wilson, M., James, S.M., Dotson, E., Edwards, C.D., Wintersteen-Arleth, L., Stevens, K., & Butterfield, P. (2021). The effects of three consecutive 12-hour shifts on cognition, sleepiness, and domains of nursing performance in day and night shift nurses: A quasi-experimental study. *Journal of Nursing Studies, 123*, 104041. Doi: 10.1016/j.ijnurstu.2021.104041

Johnson, A.L., Jung, L., Brown, K.C., Weaver, M.T., & Richards, K.C. (2014). Sleep deprivation and error in nurses who work the night shift. *The Journal of Nursing Administration, 44*(10), 17-22.

Jonasdottir, S.S., Minor, K., & Lehmann, S. (2021). Gender differences in nighttime sleep patterns and variability across the adult lifespan: A global-scale wearables study. *Sleep, 44*(2), zsaa169. Doi:10.1093/sleep/zsaa169

Jones, T. M. (2000). *Women's health nurse practitioners' perceptions of screening and diagnostic tests.* Unpublished Master's Thesis. University of Nebraska: Medical Center, Nebraska, United States of America.

Joo, J.Y., & Liu, M.F. (2021). Nurses' barriers to caring for patients with COVID-19: A qualitative systematic review. *International Nursing Review, 68*, 202-213.

Jung, H., & Lee, B. (2015). Contributors to shift work tolerance in South Korean nurses working rotating shifts. *Applied Nursing Research* 28, 150-155. Doi: 10.1016/j.apnr.2014.09.007

Karhula, K., Hakola, T., Koskinen, A., Ojajärvi, A., Kivimäki, M., & Härmä, M. (2018). Permanent night workers' sleep and psychosocial factors in hospital work. *Chronobiology International, 35*(6), 785-794.

Kawachi, I., Colditz, G.A., Stampfer, M.J., Willet, W.C., Manson, J.E., Spiezer, F.E., & Hennekens, C.H. (1995). Prospective study of shift work and risk of coronary heart disease in women. *Circulation, 92*(11), 3178-3182.

Kecklund, G., & Åkerstedt, T. (1995). Effects of timing of shifts on sleepiness and sleep duration. *Journal of Sleep Research, 4*(2), 47-50. https://doi.org/10.1111/j.1365-2869.1995.tb00226.x

Kecklund, G. & Axelsson, J. (2016). Health consequences of shift work and insufficient sleep. *British Medical Journal, 355*, 1-13. Doi:10.1136/bmj.i5210

Kervezee, L., Kosmadopoulos, A., & Boivin, D.B. (2020). Metabolic and cardiovascular consequences of shift work: The role of circadian disruption and sleep disturbances. *European Journal of Neuroscience, 51*, 396-412.

Khamisa, N., Oldenburg, B., Peltzer, K., & Ilic, D. (2015). Work related stress, burnout, job satisfaction and general health of nurses. *International Journal of Environmental Research and Public Health, 12*, 652-666. Doi: 10.3390/ijerph120100652

Khan, S., Vandermorris, A., Shepherd, J., Begun, J.W., Lanham, H.J., Uhl-Bien, M., & Berta, W. (2018). Embracing uncertainty, managing complexity: Applying complexity thinking principles to transform efforts in healthcare systems. *BMC Health Services Research, 18*(192), 1-8.

Klopper, H.C., Coetzee, S.K., Pretorius, R., & Bester, P. (2012). Practice environment, job satisfaction and burnout of critical care nurses in South Africa. *Journal of Nursing Management, 20*, 685-695**.**

Knauth, P. (1993). The design of shift systems. *Journal of Ergonomics, 36*(1-3), 15-28.

Knauth, P. (1996). Designing better shift systems. *Journal of Applied Ergonomics, 27*(1), 39-44.

Knauth, P. (1998). Innovative worktime arrangements. *Scandinavian Journal of Work, Environmental Health,* 24(3), 23-37.

Knauth, P. (2007). Extended work periods. *Industrial Health, 45*, 125-136.

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,* 267-273.

Knauth, P., & Hornberger, S. (2003). Preventive and compensatory measures for shift workers. *Occupational Medicine, 53*, 109-116.

Knuttson, A., & Bøggild, H. (2010). Gastrointestinal disorders among shift workers. *Scandinavian Journal of Work, Environment & Health, 36*(2), 85-95.

Korompeli, A., Chara, T., Chrysoula, L., & Sourtzi, P. (2013). Sleep disturbance in nursing personnel working shifts. *Nursing Forum, 48*(1), 45-53.

Korompeli, A., Muurlink, O., Tzavara, C., Velonakis, E., Lemonidou, C., & Sourtzi, P. (2014). Influence of shiftwork on Greek nursing personnel. *Safety and Health at Work, 5*(2), 73-79.

Korompeli, A., Soutzi, P., Tzavara, O., & Velonkis, E. (2009). Rotating shift-related changes in hormone levels in intensive care unit nurses. *Journal of Advanced Nursing, 65*(6), 1274-1282.

Korsiak, J., Tranmer, J., Day, A., & Aronson, K.J. (2017). Sleep duration as a mediator between an alternating day and night shift work schedule and metabolic syndrome among female hospital employees. *Occupational and Environmental Medicine, 75*(2), 132-138. Doi: 10.1136/oemed-2017-104371.

Kunzweiler, K., Voigt, K., Kugler, J., Hirsch, K., Bermann, A., & Reimenschneider, H. (2016). Factors influencing sleep quality among nursing staff: Results of a cross-sectional study. *Applied Nursing Research, 32*, 241-244.

Lee, K.A., Dziadkoweic, O., & Meek, P. (2014). A systems approach to fatigue management in research and health care. *Nursing Outlook, 62*, 313-321.

Lee, K., Hicks, G., & Nino-Murcia, G. (1991). Validity and reliability of a scale to assess fatigue. *Psychiatry Research, 36*(3), 291-298. Doi: 10.1016/0165-1781(91)90027-M

Lee, S., McCann, D., & Messenger, J.C. (2007). *Working time around the world: Trends in working hours, laws and policies in a global comparative perspective*. Geneva, Switzerland: International Labour Office. http://dx.doi.org/10.4324/9780203945216

Lee, S., Park, J.B., Lee, K., Ham, S., & Jeong, I. (2011). Effects of work organization on the occurrence and resolution of sleep disturbances among night shift worker: A longitudinal observation study. *Nature Portfolio Scientific Reports,11*, 5499. Doi:10.1038/s41598-02185017-8

Lemmer, B. (2015). Circadian rhythms. *Encyclopedia of Psychopharmacology,* 254-258. Doi: 10.1007/978-3-642-36172-2_287

Lerman, S.E., Eskin, E., Flower, D.J., George, E.C., Gerson, B., Hartenbaum, N., Hursh, S.R., & Moore-Ede, M. (2012). Fatigue risk management in the workplace. *Journal of Occupational and Environmental Medicine, 54*, 231-258.

Lin, Y., Jen, H., Lin Y., Seo, J., & Chang, W. (2022). Cortisol awakening response and stress in female nurses on monthly shift rotations: A longitudinal study. *BioMed Research International,* 2022. https://www.scienceopen.com/document_file/f6c93054-2902-40ff-a9eb-33d99be503b4/PubMedCentral/f6c93054-2902-40ff-a9eb-33d99be503b4.pdf

Linton, S.J., Kecklund, G., Franklin, K.A., Leissner, L.C., Sivertsen, B., Lindberg, E., Hansson, S.O., Sundin, Ö., Hetta, J., Björkelund, C. & Hall, C. (2015). The effect of the work environment on future sleep disturbances: A systematic review. *Sleep Medicine Reviews, 23*, 10-19.

Ljevak, I., Vasilj, I., Ćurlin, M., Šaravanja, Meštrović, T., Šimić, & Neuberg, M. (2020). The impact of shift work on psychosocial functioning and quality of life among hospital-employed nurses: a cross-sectional comparative study. *Psychiatria Danubina, 32*(2), 262-268.

Lo, W., Chien, L., Hwang, F., Huang, N., & Chiou, S. (2018). From job stress to intention to leave among hospital nurses: A structural equation modelling approach. *Journal of Advanced Nursing, 74*, 677-688.

López-Soto, P.J., Fabbian, F., Cappadona, R., Zucchi, B., Manfredini, F., García-Arcos, A., Carmona-Torres, J.M., Manfredini, R., & Rodgríguez-Borrego, M.A. (2019). Chronotype, nursing activity, and gender: A systematic review. *Journal of Advanced Nursing*, *75*, 734-748.

Mackintosh, M., Channon, A., Karan, A., Selvaraj, S., Zhao, H., & Cavagnero, E. (2016). What is the private sector? Understanding private provision in the health systems of low-income and middle-income countries. *Lancet*, 388, 596-605.

Madide, S. (2003). *Effects of night shift schedules on nurses working in a private hospital in South Africa.* Unpublished Master's Thesis, Luleå University of Technology, Sweden.

Makowiec-Dąbrowska, T., Krawczyk-Adamus, P., Sprusińska, E., & Jóźwiak, Z.W. (2000). Can nurses be employed in 12-hour shift systems? *International Journal of Occupational Safety and Ergonomics, 6*(3), 393-403. DOI: 10.1080/10803548.2000.11076463

Maphumulo, W.T., & Bhengu, B.R. (2019). Challenges of quality improvement in the healthcare of South Africa post-apartheid: A critical review. *Curations, 42*(1), a1901. DOI: 10.4102/curations.v42i1.1901

Marć, M., Bartosiewicz, A., Burzyńska, J., Chmiel, Z., & Januszewicz, P. (2019). A nursing shortage – a prospect of global and local policies. *International Nursing Review, 66*, 9-16.

Marquié, J.C., & Foret, J. (1999). Sleep, age, and shiftwork experience. *Journal of Sleep Research*, *8*(4), 297-304. https://doi.org/10.1046/j.1365-2869.1999.00170.x

Martyn, J., Grabias, K., & Chmiel, Z. (2021). Do polish nurses have a problem with sleepiness during the epidemiological threat of the SARS-CoV-2 virus? *Journal of Health Care Organization, 58*, 1-10. Doi: 10.1177/00469580211022909.

Matricciani, L., Bin, Y.S., Lallukka, T., Kronholm, E., Dumuid, D., Paquet, C., & Olds, T. (2017). Past, present and future: trends in sleep duration and implications for public health. *Sleep Health, 3*, 317-323.

McElroy, S.F., Olney, A., Hunt, C., & Glennon, C. (2020). Shift work and hospital employees: A descriptive multi-site study. *International Journal of Nursing Studies, 112*, 1-7.

Melariri, H.I., Kalinda, C., & Chimbar, M.J. (2021). Training, attitudes and practice (TAP) among healthcare professional in the Nelson Mandela Bay Municipality, South Africa: A health promotion and disease prevention perspective. *PLoS ONE, 16(*11), e0259884, 1-16. https://doi.org/10.1371/journal.pone.0259884

Messenger, J.C., & Vidal, P. (2015). *The organisation of working time and its effects in the health services sector: A comparative analysis of Brazil, South Africa and the Republic of Korea. Conditions of Work and Employment Series No. 56*. Geneva, Switzerland: International Labour Office. https://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---travail/documents/publication/wcms_342363.pdf

Mignot, E. (2008). Why we sleep: The temporal orgnisation of recovery. *PLoS Biology, 6*(4). 661-669. Doi: 10.1371/journal.pbio.0060106

Min., A., Hong, H., Son, S, & Lee, T. (2021). Sleep, fatigue and alertness during working hours among rotating-shift nurses in Korea: An observational study. *Journal of Nursing Management,* 29(8), 2647-2657. Doi: 10.1111/jonm.13446

Min, A., Min, H., & Chong Hong, H. (2019). Work schedule characteristics and fatigue among rotating shift nruses in hospital setting: An integrative review. *Journal of Nursing Management,* 27, 884-895. Doi: 10.111/jonm.12756

Molzof, H.E., Prapanjaroensin, A., Patel, V.H., Mokashi, M.V., Gamble, M.L., & Patrician, P.A. (2019). Misaligned core body temperature rhythms impact cognitive performance of hospital shift work nurses. *Neurobiology of Learning and Memory,160*, 151-159.

Monk, T.H. (1989). A visual analogue scale technique to measure global vigor and affect. *Psychiatry Research, 27*, 89-99.

Monk, T.H. (2005). The post-lunch dip in performance. *Clinical Sports Medicine,* 24(2), e15-e23. Doi: 10.1016/j.csm.2004.12.002

Monk, T.H., Moline, M.L., Fookson, J.E., & Peetz, S.M. (1989). Circadian determinants of subjective alertness. *Journal of Biological Rhythms, 4*(4), 393-404.

Moreno, C.R.C., Marqueze, E., Sargent, C., Wright, K.P., Ferguson, S.A., & Tucker, P. (2019). Working time society consensus statements: Evidence-based effects of shift work on physical and mental health. *Industrial Health,* 57, 139-157.

Mosendane, T., Mosendane, T., & Raal, F.J. (2008). Shift work and its effects on the cardiovascular system. *Cardiovascular Journal of Africa, 19*(4), 210-215.

Murillo-Rodriguez, E., Yamamoto, T., Veras, A.B., Rocha, N.B., Telles-Correira, D., Machado, S., Monterio, D., Budde, H., & Torterolo, P. (2019). Sleep disorders and genes. In E. Murillo-Rodriguez (Ed.), *The behavioural, molecular, pharmacological, and clinical basis of the sleep-wake cycle* (pp. 143-158). Elsevier. https://doi.org/10.1016/B978-0-12-816430-3.00008-7

Nashwan, A.J., Villar, R.C., Al-Qudimat, A.R., Kader, N., Alabdulla, M., Abujaber, A.A., Al-Jabry, M.M., Harkous, M., Philip, A., Ali, R., Chandra, P., Yassin, M.A., Shraim, M., & Singh, K. (2021). Quality of life, sleep quality, depression, anxiety, stress, eating habits, and social bounds in nurses during the coronavirus disease 2019 pandemic in Qatar (The Protector Study): A cross-sectional comparative study. *Journal of Personalized Medicine, 11*(918), 1-12. Doi: 10.3390/jpm11090918.

National Academies of Sciences, Engineering, and Medicine. (2018). *Crossing the global quality chasm: Improving health care worldwide*. Washington, DC: The National Academies Press.

Nelson, K.L., Davis, J.E., & Corbett, C.F. (2022). Sleep quality: An evolutionary concept analysis. *Nursing Forum*, *57*, 144-151. Doi: 10.1111/nuf.12659

Nilsson, K., Campbell, & Anderson, E.P. (2008). Night nursing – staffing's working experiences. *BioMed Central, 7*(13), 1-9. Doi: 10.1186/1472-6955/7/13.

Niu, S., Chung, M., Chu, H., Tsai, J., Lin, C., Liao, Y., Ou, K., O'Brien, A.P., & Chou, K. (2015). Difference in cortisol profiles and circadian adjustment time between nurses working night shifts and regular day shifts: A prospective longitudinal study. *International Journal of Nursing Studies, 52*, 1193-1201. Doi:10.1016/j.ijnurstu.2015.04.001

Niu, S., Miao, N., Liao, Y., Chi, M., Chung, M., & Chou, K. (2017). Sleep quality: associated with different work schedules: A longitudinal study of nursing staff. *Biological Research for Nursing, 19*(4) 375-381.

Nurminen, T. (1998). Shift work and reproductive health. *Scandinavian Journal of work and Environmental Health, 24*(3), 23-27.

Nursing Act. (2005). *Act No. 33 of 2005, Nursing Act. Government Gazette 28883, Notice 492, 29 May 2006*. Cape Town: South African Parliament. https://www.gov.za/sites/default/files/gcis_document/201409/a33-050.pdf

Oh, H., & Cho, S. (2020). Effects of nurses' shiftwork characteristics and aspects of private life on work-life conflict. *PLoS One, 15*(12), e0242379. Doi: 10.1371/journal.pone.0242379

Oleribe, O.O., Momoh, J., Uzochukwu, B.S.C., Mbofana, F., Adebiyi, A., Barbera, T., Williams, R., & Taylor-Robinson, S.D. (2019). Identifying key challenges facing healthcare systems in Africa and potential solutions. *International Journal of General Medicine, 12,* 395-403.

Overeem, S., Lammers, G.J., & Tafti, M. (2007). Disorders of sleep and circadian rhythms. In S.G. Waxman (Ed.), *Molecular neurology* (pp. 409-426). Elsevier. https://doi.org/10.1016/B978-0-12-369509-3.X5001-X

Owens, B., Allen, W., & Moultrie, D. (2017). The impact of shift work on nurses' quality of sleep. *ABNF Journal, 28*(3), 59-63.

Owens, J.A. (2007). Sleep loss and fatigue in healthcare professionals. *Journal of Perinatal & Neonatal Nursing, 21*(2), 92-100.

Owens, J.F., & Matthews, K.A. (1998). Sleep disturbance in healthy middle-aged women. *Maturitas, 30*, 41-50.

Paoli, P., & Merllié, D. (2001). *Third European survey on working conditions 2000*. Ireland: Eurofound. https://policycommons.net/artifacts/1830735/third-european-survey-on-working-conditions-2000/2571485/

Palhares, V.D.C., Corrente, J.E., & Matsubara, B.B. (2014). Association between sleep quality and quality of life in nursing professional working rotating shifts. *Revista de Saúdi Pública, 48*(4), 594-601.

Papantoniou, K., Castaño-Vinyals, G., Espinosa, A., Aragonés, N., Pérez-Gómez, B., Burgos, J., Gómez-Acebo, I., Llorca, J., Peiro, R., Jimenez-Moleón, J.J., Arredondo, F., Tardón, A., Pollan, M., & Kogevinas, M. (2015). Night shift work, chronotype and prostate cancer risk in the MCC-Spain case control study. *International Journal of Cancer,137*, 1147-1157.

Parent-Thirion, A., Biletta, I., Cabrita, J., Vargas, O., Vermeylen, G., Wilczynska, A., & Wilkens, M. (2017). *Sixth European working conditions survey. Overview report*. Luxenburg: Eurofound/ European Union. https://www.eurofound.europa.eu/publications/report/2016/working-conditions/sixth-european-working-conditions-survey-overview-report

Parreria, P., Santos-Costa, P., Neri, M., Marques, A., Queirós, P., & Salgueiro-Oliveira, A. (2021). Work methods for nursing care delivery. *International Journal of Environmental Research and Public Health, 18*(2088), 1-17. Doi: 10.3390/ijerph18042088

Paruthi, S., Brooks, L.J., D'Ambrosio, C., Hall, W.A., Kotgal, S., Lloyd, R.M., Malow, B.A., Maski, K., Nichols, C., Quan, S.F., Rosen, C.L., Troester, M.M., Wise, M.S. (2016). Consensus statement of the American Academy of sleep medicine on the recommended amount of sleep for healthy children: Methodology and discussion. *Journal of Clinical Sleep Medicine, 12*(11), 1549-1561.

Paterson, J.L., Sofianopoulos, S., & Williams, B. (2014). What paramedics think about when they think about fatigue: Contributing factors. *Emergency Medicine Australia, 26*, 139-144.

Petrov, M.E., Clark, C/B/. Molzof, H.E., Johnson Jr., R.L., Cropsey, K.L., & Gamble, K.L. (2014). Sleep strategies of night shift nurses on days off: which ones are

most adaptive. *Frontiers in Neurology, 5*(277), 1-8. Doi: 10.3389/fneur.2014.00277

Phillips, J., Richard, A., Mayer, K.M., Shilkaitis, M., Fogg, L.F., & Vondracek, H. (2020). Integrating the social determinants of health into nursing practice: nurses' perspectives. *Journal of Nursing Scholarship, 52*(5), 497-505. Doi:10.1111/jnu.12584

Pillay, R. (2009). Work satisfaction of professional nurses in South Africa: a comparative analysis of the public and private sectors. *Human Resources for Health, 7*(15), 1-10. Doi:10.1186/1478-4491-7-15.

Pittman, P. (2013). Nursing workforce education, migration and the quality of health care: A global challenge. *International Journal for Quality in Health Care, 25*(4), 349-351.

Protection of Personal Information Act (POPIA). (2013). Act No. 4 of 2013, *Protection of Personal Information Act*. *Government Gazette No. 37067*, *26 November 2013.* Cape Town, South Africa: Parliament. https://www.gov.za/sites/default/files/gcis_document/201409/3706726-11act4of2013protectionofpersonalinforcorrect.pdf

Putri, N.W., & Rahayu, D. (2019). Work stress among nurses of hospitalized patient room at RSI Siti Rahmah. *Proceedings: Third Andalas International Public Health Conference (AIPHC). Padang, Indonesia, 10-11 October 2019,* 170-178. http://dx.doi.org/10.4108/eai.9-10-2019.2297233

Qiu, D., Yu, Y., Li, R., & Xiao, S. (2020). Prevalence of sleep disorders in Chinese healthcare professionals: A systematic review and meta-analysis. *Sleep Medicine, 67,* 258-266. Doi: 10.1016/j.sleep.2019.01.047

Querstret, D., O'Brien, K., Skene, D.J., Aiken, L.H., & Dinges, D.F. (2020). Improving fatigue risk management in healthcare: A scoping view of sleep-related fatigue management interventions for nurses and midwives. *International Journal of Nursing Studies, 112*, 1-16.

Ramkisoensing, A., & Meijer, J.H. (2015). Synchronization of the biological clock neurons by light and peripheral feedback systems promotes circadian rhythms

and health. *Frontiers in Neurology, 6*(128), 1-16. Doi:10.3389/fneur.2015.00128.

Rathore, H., Shukla, K., Singh, S., & Tiwari, G. (2012). Shift work – problems and its impact on female nurses in Udaipur, Rajasthan, India. *Work, 41*, 4302-4314.

Ream, E., & Richardson, A. (1997). Fatigue in patients with cancer and chronic obstructive airways disease: A phenomenological enquiry. *International Journal of Nursing Studies, 24*(1), 44-53.

Reed, D.L., & Sacco, W.P. (2016). Measuring sleep efficiency. What should the denominator be? *Journal of Clinical Sleep Medicine, 12*(2), 263-266.

Reutter, L., & Kushner, K.E. (2010). 'Health equity through action on the social determinants of health': Taking up the challenge in nursing. *Nursing Inquiry, 17*(3), 269-280.

Reynolds, J., Wisaijohn, T., Pudpong, N., Watthayu, N., Dalliston, A., Suphanchaimat, R., Putthasri, W., & Sawaengdee, K. (2013). A literature review: The role of the private sector in the production of nurses in India, Kenya, South Africa, and Thailand. *Human Resources for Health, 11*(14), 1-12.

Rheume A, & Mullin, J. (2018). The impact of long working hours and shift work on cognitive errors in nurses. *Journal of Nursing Management, 26*, 26-32. Doi: 10.1111/jonm.12513

Rispel, L.C., Blaauw, D., Chirwa, T., & De Wet, K. (2014). Factors influencing agency nursing and moonlighting among nurses in South Africa. *Global Health Action,*7(1):23585, 1-11. Doi: 10.13402?gha.v7.23585

Rogers, A.E. (2008). The effects of fatigue and sleepiness on nurse performance and patient safety. In R.G. Hughes (Ed.), *Patient safety and quality: An evidence-based handbook for nurses* (Chapter 40). Rockville: Agency for Healthcare Research and Quality.

Rogers, A.E., Hwang, W., Scott, L.D., Aiken, L.H., & Dinges, D.F. (2004). The working hours of hospital staff nurses and patient safety. *Health Affairs, 23*(2), 202-212.

Rosa, R.R., Härma, M., Pulli, K., Mulder, M., & Näsman, O. (1996). Rescheduling a three-shift system at a steel rolling mill: Effects on sleep and alertness in

younger and older workers. *Occupational and Environmental Medicine, 53*, 677-685.

Rosa, D., Terzoni, S., Dellafiore, F., & Destrebecq, A. (2019). Systematic review of shift work and nurses' health. *Occupational Medicine, 69*(4), 237-243. Doi: 10.1093/occmed/kqz063

Ruggerio, J.S. (2003). Correlates of fatigue in critical care nurses. *Research in Nursing & Health*, *26*, 434-444. doi: 10.1002/nur.10106

Ryan, C., Bergin, M., White, M., & Wells, J.S.G. (2019). Aging in the nursing workforce – a global challenge in an Irish context. *International Nursing Review*, *66*, 157-164.

Sagaspe, P., Taillard, J., Amiéya, H., Beck, A., Rascol, O., Dartigues, F., Capelli, A., & Philip, P. (2012). Influence of age, circadian and homeostatic processes on inhibitory motor control: A go/nogo task study. *PLoS ONE, 7*(6), e39410.

Sahlin, C., Franklin, K.A., Stenlund, H., & Lindberg, E. (2009). Sleep in women: Normal values for sleep stages and position and the effect of age, obesity, sleep apnea, smoking, alcohol, and hypertension. *Sleep Medicine, 10*, 1025-1030.

Saksvik-Lehouillier, I., Bjorvatn, B., Hetland, H., Sandal, G.M., Moen, B.E., Magerøy, N., Åkerstedt, T., & Pallesen, S. (2012). Individual, situational and lifestyle factors related to shift work tolerance among nurses who are new to and experienced in night work. *Journal of Advanced Nursing, 69*(5), 1136-1146. Doi:10.1111/j.1365-2648.2012.06105.x

Saksvik, I., Bjorvatn, B., Hetland, H., Sandal, G.M., & Pallesen, S. (2011). Individual differences in tolerance to shift work – A systematic review. *Sleep Medicine Reviews, 15*, 221-235.

Saleh, M., Elhady, H.M., Waly, M.H., Elbakry, S.T., Biaoumy, E., & Zaki, M.S. (2018). Shiftwork-related problems among nurses working in Benha University Hospital, Egypt. *Menoufia Medical Journal, 31*, 619-628.

Sallinen, M., & Kecklund, G. (2010). Shift work, sleep, and sleepiness – differences between shift schedules and systems. *Scandinavian Journal of Work, Environment & Health, 36*(2), 121-133.

Salo, P., Ala-Mursula, L., Rod, N.H., Tucker, P., Pentti, J., Kivimäki, M., Vahtera, J. (2014). Work time control and sleep disturbances: prospective cohort study of Finnish public sector employees *Sleep,* 37(7), 1217-1225. http://dx.doi.org/10.5665/sleep.3842

Samaha, E., Lal, S., Sahama, N., & Wyndham, J. (2017). Psychological, lifestyle and coping contributors to chronic fatigue in shift-worker nurses. *Journal of Advanced Nursing*, *59*(2), 221-232.

Saville, C., Dall'Ora, C., & Griffiths, P. (2020). The association between 12-hour shifts and nurses-in-charge's perceptions of missed care and staffing adequacy: A retrospective, cross-sectional observational study. *International Journal of Nursing Studies, 112*, 103721.

Seong, J., Son, S., & Min, A. (2021). Effect of sleep and alertness at work among fixed night shift nurses: A prospective observational study. *Journal of Advanced Nursing, 78*, 3197-3206. Doi:10.111/jan15180.

Schluter, J., Seaton, P., & Chaboyer, W. (2011). Understanding nursing scope of practice. *International Journal of Nursing Studies, 48*, 1211-1222.

Shao, M., Chou, Y., Yeh, M., & Tzeng, W. (2010). Sleep quality and quality of life in female shift-working nurses, *Journal of Advanced Nursing, 66*(7), 1565-1572.

Shen, J., Barbera, J., & Shapiro, C.M. (2006). Distinguishing sleepiness and fatigue: Focus on definition and measurement. *Sleep Medicine Reviews, 10*, 63-76.

Sherman, R.O., Chiang-Hanisko, L., & Koszalinski, C.E.L. (2013). The aging nursing workforce: A global challenge. *Journal of Nursing Management, 21*, 899-902.

Shiffer, S., Minonzio, M., Dipaola, F., Bertola, M., Zamuner, A.R., Vecchia, L.A.D., Solbiati, M., Costantino, G., Furlan, R., & Barbic, F. (2018). Effects of clockwise and counterclockwise job shift work rotation on sleep and work-life balance on hospital nurses. *International Journal of Environmental Research and Public Health,15*(2038), 1-10.

Shrivastava, D., Jung, S., Saadat, M., Sirohi, R., & Crewson, K. (2014). How to interpret the results of a sleep study. *Journal of Community Hospital Internal Medicine Perspectives, 4*(24983). Doi: 10.3402/jchimp.v4:24983.

Schrecker T., & Labonte, R. (2004) Taming the brain drain: A challenge for public health systems in Southern Africa. *International Journal of Occupational and Environmental Health, 10*(4), 409-415. Doi: 10.1179/oeh.2004.10.4.409

Silva, I.S., & Bastos, R. (2018). Shift work – change from semi-continuous to continuous system. *Journal of Organizational Change Management, 31*(7), 1461-1470.

Silva, A., Silva, A., Duarte, J., & Torres Costa, J. (2020). Shift work: A review of the health consequences. *International Journal of Occupational and Environmental Safety, 4*(2), 48-79.

Silva, E.J., Wang, W., Ronda, J.M., Wyatt, J.K., & Duffy, J.F. (2010). Circadian wake-dependent influences on subjective sleepiness, cognitive throughput, and reaction time performance in older and young adults. *Journal of Sleep, 33*(4), 481-490.

Silva-Costa, A., Griep, R., FIscher, F, Rotenber, L. (2012). Need for recovery from work and sleep-related complaints among nursing professionals. *Work, 41*, 3726-3731 doi10.3233/WOR-2012-0086-3726

Smith-Miller, C.A., Shaw-Kokot, J., Curo, B., & Jones, C.B. (2014). An integrative review: Fatigue among nurses in acute care settings. *The Journal of Nursing Administration, 44*(9), 487-494.

Smurra, M.V., Dury, M., Aubert, G., Rodenstein, D.O., & Liistro, G. (2001). Sleep fragmentation comparison of two definitions of short arousals during sleep in OSAS patients. *European Respiratory Journal, 17*, 723-727.

South African Nursing Council (SANC). (2021). *South African Nursing Council Professional Practice for Nurses and Midwives*. URL: https://www.sanc.co.za/professional-practice/# Last Accessed: 15 November 2021.

Steege, L.M., Drake, D.A., Olivas, M., & Mazza, G. (2015). Evaluation of physically and mentally fatiguing tasks and sources of fatigue as reported by registered nurses. *Journal of Nursing Management, 23*, 179-189.

Stimpfel, A.W., Sloane, D.M., & Aiken, L.H. (2012). The longer the shifts for hospital nurses, the higher the levels of burnout and patient dissatisfaction. *Health Affairs, 33*(11), 2501-2510.

Sturmberg, J. (2012). Health care policy that meets the patient's needs. *Emergence: Complexity & Organization,14*(4), 86-104.

Sun, Q., Ji, X., Zhou, W., & Liu, J. (2019). Sleep problems in shift nurses: A brief review and recommendations at both individual and institutional levels. *Journal of Nursing Management, 27*, 10-18. Doi: 10.1111/jonm.12656

Surrender, R., Van Niekerk R., Hannah, B., Allan, L., & Shung-King, M. (2015). The drive for universal healthcare in South Africa: View from private general practitioners. *Health Policy and Planning, 30*, 759-767.

Sveinsdóttir, H. (2006). Self-assessed quality of sleep, occupational health, working environment, illness experience and job satisfaction of female nurses working different combination of shifts. *Scandinavian Journal of Caring Science, 20*, 229-237.

Techera, U., Hallowell, M., Stamburgh, N., & Littlejohn, R. (2016). Causes and consequences of occupational fatigue: Meta-analysis and systems model. *Journal of Occupational and Environmental Medicine, 58*(10), 961-937.

Terreblanche, M., Durrheim, K., & Painter, D. (2006). *Research in practice: Applied methods for social sciences* (2nd ed.). Cape Town: University of Cape Town Press.

Teng, C., Hsiao, F., & Chou, T. (2010). Nurse-perceived time pressure and patient-perceived care quality. *Journal of Nursing Management, 18*(3), 275-284. Doi: 10.1111/j.1365-2834.2010.01073.x

Trinkoff, A.M., Le, R., Geiger-Brown, J., & Lipscomb, J. (2007). Work schedule, needle use, and needlestick injuries among registered nurses. *Infection Control and Hospital Epidemiology, 28* (2), 156-164. Doi: 10.1086/510785

Trinkoff, A.M., Le, R., Geiger-Brown, J., Lipscomb, J., & Lang, G. (2006). Longitudinal relationship of work hours, mandatory overtime, and on-call to musculoskeletal problems in nurses. *American Journal of Industrial Medicine, 49*, 964-971.

Tucker, P., & Folkard, S. (2012). *Working time, health, and safety: A research synthesis paper. Conditions of work and Employment series No. 31*. Geneva, Switzerland: International Labour Office. https://www.ilo.org/travail/info/publications/WCMS_181673/lang--en/index.htm

Tucker, P., & Knowles, S.R. (2008). Review of studies that have used the Standard Shiftwork Index: Evidence for the underlying model of shiftwork and health. *Journal of Applied Ergonomics, 39*, 550-564.

Tucker, P., Smith, L., Macdonald, I., & Folkard, S. (2000). Effects of direction of rotation in continuous and discontinuous 8-hour shift systems. *Occupational and Environmental Medicine, 57*(10), 678-683.

Van Amelsvoort, L.G.P.M., Jansen, N.W.H., Swaen, G.M.H., Van den Brandt, P.A., & Kant, I. (2004). Direction of shift rotation among three-shift worker in relation to psychological health and work-family conflict. *Scandinavian Journal of Work, Environment and Health*, *30*(2), 149-156.

Van der Heijden, B., Brown Mahoney, C., & Xu, Y. (2019). Impact of job demands and resources on nurses' burnout and occupational turnover intention towards an age-moderated mediation model for the nursing profession. *International Journal of Environmental Research and Public Health, 16*(2011), 1-22. Doi:10.3390/ijerph16112011

Van Dongen, H.P.A., & Dinges, D.F. (2000). Circadian rhythms in fatigue, alertness and performance. In M.H. Kryger, T. Roth, & W.C. Dement (Eds.), *Principles and practice of sleep medicine* (3rd ed., pp. 391-399). Philadelphia, Pennsylvania: Saunders. *Principles and practice of sleep medicine* (5th ed.). Elsevier. Doi:10.1016/C2009-0-59875-3

Van Dongen, H.P.A., Rogers, N.L., & Dinges, D.F. (2003). Sleep debt: Theoretical and empirical issues. *Sleep and Biological Rhythms, 1*, 5-13.

Van Ryneveld, M., Scheider, H., & Lehman, U. (2020). Looking back to look forward: A review of human resources for health governance in South Africa from 1994-2018. *Human Resources for Health, 18*(92), 1-10. Doi: 10.1186/s12960-020-00536-1

Vedaa, O., Harris, A., Bjorvatn, B., Waage, S., Sivertsen, B., Tucker, P., & Pallesan, S. (2015). Systematic review of the relationship between quick returns in rotating shift work and health related outcomes. *Ergonomics, 59*(1), 1-14. Doi:10.1080/00140139.2015.1052020.

Visagie, J., & Turok, I. (2021). Rural-urban inequalities amplified by COVID-19: evidence from South Africa. *Area Development and Policy, 6*(1), 50-62. Doi: 10.1080/23792949.2020.1851143

Visser, D. (1999). Validity of the Standard Shiftwork Index for South African shiftworkers in the transport industry. *Journal of Industrial Psychology, 25*(1), 44-52.

Vitaterna, M.H., Takahashik, J.S., & Turek, F.W. (2001). Overview of circadian rhythms. *Alcohol Research and Health, 25*(2), 85-93.

Wahl, S., Engelhardt, M., Schaupp, P., Lappe, C., & Ivanov, I.V. (2019). The inner clock – Blue light sets the human rhythm. *Journal of Biophotonics, 12*, e201900102. doi: 10.1002/jbio.201900102.

West, S., Rudge, T., & Mapedzahama, V. (2016). Conceptualizing nurses' night work: An inductive content analysis. *Journal of Advanced Nursing,* 1899-1914. Doi: 10.1111/jan.12966

White, F. (2015). Primary health care and public health: Foundations of universal health systems. *Medical principles and Practice, 24*, 103-116.

Wickwire, E.M., Geiger-Brown, J., Scharf, S.M., & Drake, C.L. (2017). Shift work and shift work sleep disorder: Clinical and organizational perspectives. *CHEST, 15*(5), 1156-1172. Doi:10.1016/j.chest.2016.12.007

Williamson, A., & Friswell, R. (2013). Fatigue in the workplace: Causes and countermeasures. *Fatigue: Biomedicine, Health and Behavior, 1*, 81-98.

Wilking, M., Ndiaye, M., Mukhar, H., & Ahmad, N. (2012). Circadian rhythm connections to oxidative stress: implications for human health. *Antioxidants & Redox Signaling,* 19(2), 192-208. Doi: 10.1089.ars.20124889

Wilson, J.L. (2002). The impact of shift patterns on healthcare professionals. *Journal of Nursing Management, 10*, 211-219.

Wilson, L., Mendes, I.A.C., Lopper, H., Catrambone, C., Al-Maaitah, Norton, M.E., & Hill, M. (2016). “Global health” and “global nursing”: Proposed definitions from The Global Advisory Panel on the future of nursing. *Journal of Advanced Nursing, 72*(7), 1529-1540.

Wilson, M., Permitto, R., English, A., Albritton, S., Coogle, C., & Van Dongen, H.P.A. (2019). Performance and sleepiness in nurses working 12-hour day shifts or night shifts in a community hospital. *Accident Analysis and Prevention,126*, 43-46.

Winwood, P.C., Winefield, A.H., & Lushington, K. (2006). Work-related fatigue and recovery: The contribution of age, domestic responsibilities and shiftwork. *Nursing and Healthcare Management and Policy*, *56*(4), 438-449. Doi:10.1111/j.1365-2648.2006.04011.x

Wittmann, M., Dirch, J., Merrow, M., Roenneberg, T. (2006). Social jetlag: misalignment of biological and social time. *Chronobiology International, 23*(1&2), 497-509.

Wright, K.P., Lowry, C.A., & Le Bourgeois, M.K. (2012). Circadian and wakefulness-sleep modulation of cognition in humans. *Frontiers in Molecular Neuroscience, 5*(50), 1-12.

World Health Organisation (2000). The World Health Report. Health Sytems: *Improving Performance.* Geneva, Switzerland: World Health Organisation.

World Health Organisation (2002). The World Health Report: Reducing risk, promoting healthy life. Geneva, Switzerland: World Health Organisation.

World Health Organisation. (2007). *Everybody’s business – strengthening health systems to improve health outcomes: WHO’s framework for action*. Geneva, Switzerland: World Health Organisation.

World Health Organisation. (2015). *Health in 2015: From millennium development goals (MDGs) to sustainable development goals (SDGs)*. France: World Health Organisation.

Yamaguchi, Y., Inoue, T., Harada, H., & Oike, M. (2016). Job control, work-family balance and nurses’ intention to leave their profession and organization: A

comparative cross-sectional survey. *International Journal of Nursing Studies, 64*, 52-62.

Yates, V., & Lillie, E. (2019). Challenges in healthcare delivery in developing nations. *Anaesthesia and Intensive Care Medicine, 20*(9), 532-535.

Yazdi, Z., Sadeghniiat-Haghighi, K., Javadi, A.R.H.S., & Rikhtegar, G. (2014). Sleep quality and insomnia in nurses with different circadian chronotypes: Morningness and eveningness orientation. *Work*, *47*, 561-567.

Yoo, G., & Kim, T.W. (2017). The effect of morningness-eveningness on shift work nurses: Sleep quality, depressive symptoms and occupational stress. *Sleep Medicine Research, 8*(1), 39-43.

Young, M. (2016). Private vs. public healthcare in South Africa. Unpublished Honour's Thesis. Scholar Works at Western Michigan University.

Yuan, S.C., Chou, M.C., Chen, C.J., Lin, Y.J., Chen, M., Liu, H., & Kuo, H. (2011). Influences of shift work on fatigue in nurses. *Journal of Nursing Management, 19*, 339-345.

Yun, S., Kim, M., Lee, W-T., Yoon, J-H., & Won, J-U. (2021). Irregular work hours and the risk of sleep disturbance among Korean service workers required to suppress emotion. *International Journal of Environmental Research and Public Health, 18*(1517), 1-12. Doi:10.3390/ijerph18041517

Zhang, Y., Duffy, J.F, de Castillero, E.R., & Wang, K. (2018). Chronotype, sleep characteristics, and musculoskeletal disorders among hospital nurses. *Workplace Health and Safety,* 66(1), 8-15. Doi: 10.1177/216507991779471

Zion, N., Drach-Zahavy, A., & Shochat, T. (2018). Who is sleepier on the night shift? The influence of bio-psycho-social factors on subjective sleepiness of female nurses during the night shift. *Ergonomics, 61*(7). 1004-1014. Doi:10.1080/00140139.2017.1418027

APPENDICES

APPENDIX A- RHODES UNIVERSITY ETHICS APPROVAL

RHODES UNIVERSITY
Where leaders learn

Rhodes University Human Ethics Committee
PO Box 94, Makhanda, 6140, South Africa
t: +27 (0) 46 603 7727
f: +27 (0) 46 603 8822
e: s.mangele@ru.ac.za
NHREC Registration number: RC-241114-045

https://www.ru.ac.za/researchgateway/ethics/

22 November 2021

Dr Jonathan Davy

Email: jonathan.davy@ru.ac.za

Review Reference: 2021-5040-6245

Dear Dr Jonathan Davy

Title: The impact of shift work on nurses' sleep and fatigue in selected, private healthcare facilities in the Eastern Cape.

Principal Investigator: Dr Jonathan Davy

Collaborators: Miss Emma Bell, Mr Andrew Todd

This letter confirms that the above research proposal has been reviewed and **APPROVED** by the Rhodes University Human Ethics Committee (RU-HEC). Your Approval number is: 2021-5040-6245

Approval has been granted for 1 year. An annual progress report will be required in order to renew approval for an additional period. You will receive an email notifying you when the annual report is due.

Please ensure that the ethical standards committee is notified should any substantive change(s) be made, for whatever reason, during the research process. This includes changes in investigators. Please also ensure that a brief report is submitted to the ethics committee on the completion of the research. The purpose of this report is to indicate whether the research was conducted successfully, if any aspects could not be completed, or if any problems arose that the ethical standards committee should be aware of. If a thesis or dissertation arising from this research is submitted to the library's electronic theses and dissertations (ETD) repository, please notify the committee of the date of submission and/or any reference or cataloguing number allocated.

Sincerely,

Prof Arthur Webb

Chair: Rhodes University Human Ethics Committee, RU-HEC

cc: Ms Danielle de Vos - Ethics Coordinator

APPENDIX B- GATEKEEPER ETHICS APPROVAL

employee of the life Group, the research must be conducted within one year of permission being given by the Company, OR must be completed in the proposed time period specified in the approved proposal. Permission may be withdrawn if the research extends beyond the approved time period.

5. [REDACTED] will not take responsibility for any unforeseen circumstances within its institutions which may materially change the context and potential outcomes of a student's research. Should this occur, the student will be required to approach their Higher Learning institution for guidance around alternatives.
6. [REDACTED] will not be liable for any costs incurred during or related to this study.
7. In cases where a researcher is found to be guilty of misconduct, or in contravention of any national or international legislation or [REDACTED] policies or guidelines, permission to continue with the research will be withdrawn immediately pending investigation. In the case of student research, the higher education institution under which the researcher is registered will be notified. In the case of a clinical trial, The South African Health Products Regulatory Authority (SAPHRA) will be notified, as well as the trial sponsor and any other necessary parties.

Yours sincerely,

Dr Sharon Vasuthevan
[REDACTED] HREC Chairperson

Prof Esmeralda Ricks
Research Associate

_____

On behalf of the [REDACTED]
Health Research Ethics Committee

APPENDIX C- RECRUITMENT POSTER

ATTENTION ALL NURSES AT [REDACTED] HOSPITAL, [REDACTED], AND [REDACTED] UNIT

OPPORTUNITY TO TAKE PART IN MASTERS SHIFT WORK RESEARCH: 1 DECEMBER 2021 to 28 FEBRUARY 2022

The Department of Human Kinetics and Ergonomics invites interested **NURSES** to participate in a Masters research determining the impact of shift work on nurses' sleep and fatigue in selected, private hospitals in the Eastern Cape.

DATES: 1 December 2021- 28 February 2022. This ensures that completing the questionnaire does not interfere with your work and home life.

WHERE: [REDACTED], [REDACTED], and [REDACTED] Unit.

INCLUSION CRITERIA: In order to participate, interested individuals should be nurses employed by [REDACTED], [REDACTED], or the [REDACTED] Unit or employed to work at these facilities through a Nursing Agency, and **working shifts and registered with SANC**.

ETHICAL CLEARANCE NUMBER: **[REDACTED] HREC - REF: 29092021/4**
Rhodes University : 2021-5040-6245

BENEFITS: Interested participants become aware of various outcomes of shift work that may aid in changing how shifts are scheduled to improve the overall health, safety and well-being of the participants. The information we obtain will further aid the implementation of preventative and/or mitigating policies for shift work.

WHAT YOU HAVE TO DO: During the allotted 3 months of data collection time, (1 Dec 2021 – 28 Feb 2022), you will have to fill in survey (a battery of questionnaires) pertaining to general demographic information, sleep and fatigue, your shift systems, and time of day preference for completing work-related tasks.

IF YOU INTERESTED OR WOULD LIKE MORE INFORMATION, PLEASE CONTACT
EMMA BELL: Email: g16b3543@campus.ru.ac.za or Cell: -764587713,
JONATHAN DAVY: Email: j.davy@ru.ac.za or Cell: 072 226 0430
ANDREW TODD: Email: a.todd@ru.ac.za or Cell: 0832770795

RHODES UNIVERSITY
Where leaders learn

Determining the impact of shift work on nurses' sleep and fatigue in selected, private hospitals in the Eastern Cape.

Nurses have been required to work in shifts, enduring physically and mentally demanding workloads, to provide 24-hour care to patients. Previous shift work research in healthcare has highlighted that nurses are experiencing extended hours of wakefulness, reduced recovery, circadian desynchrony, changes in sleep/wake behaviours, which all contribute to poor sleep quality and insufficient sleep. Although there is ample research on sleep in healthcare, there is limited research available pertaining to how shift work impacts the South African, private nurse population.

Aims of the study

This study aims to determine the impact of shift work on nurses reported sleep and fatigue of selected, private healthcare nurses in the Eastern Cape through the use of an amended version of the Standard Shiftwork Index (SSI), a battery of questionnaires that explores the impact of shift work on sleep/wake behaviours, energy, physical and mental health, job satisfaction, changes in social and domestic life, and demographic information. For the purpose of this study, only questions pertaining to sleep, fatigue, time of day preference for activities, general demographic information, and your shift systems will be explored. Understanding the impact of different shift arrangements on nurse's reported sleep and fatigue is important, given the effects that sleepiness and fatigue may have on nurse alertness and performance when interacting during the care process. This study will also explore the impact of personal characteristics such as gender, age, work experience and number of children on your reported sleep and fatigue as a result of the shifts you work.

Due to the COVID-19 pandemic, we have made the questionnaire available online and as a hard copy to reduce contact sessions that may result in increased infection rates.

If you choose to participate in this study, please answer EVERY QUESTION and pay particular attention to the descriptions of each question as they provide explanations to aid your answering. You are NOT required to provide your name, as your information will remain ANONYMOUS. If you choose to withdraw from the study at point during data collection, you have the right to do so without any consequences.

BY COMPLETING THIS QUESTIONNAIRE, YOU ACKNOWLEDGE CONSENT TO PARTICIPATE IN THIS STUDY. Please tick the box in the consent clause below.

Please note that there are questions that may highlight various negative effects of shift work. If these outcomes concern you, especially the physical and mental health questions, after completing the questionnaire, please see your GENERAL PRACTITIONER, as we are not trained to give any clinical advice to participants.

After data collection, the information obtained from you will be stored and analyzed with confidentiality. Thereafter, the results of this study will be presented to the matron of the

8 How many persons in your household are in each of the following age groups? 0-

10/15/21, 4:25 PM Determining the impact of shift work on nurses' sleep and fatigue in selected, private hospitals in the Eastern Cape.

hospital and distributed among nurses using the most relevant.

Ethical clearance number:
Ethics Committee coordinator: Siyanda Manqele
Email: ethics-committee@ru.ac.za

If you have any questions pertaining to this study, please contact:
EMMA BELL: Email: g16b3543@campus.ru.ac.za or Cell: 0764587713
JONATHAN DAVY: Email: j.davy@ru.ac.za or Cell: 072 226 0430
ANDREW TODD: Email: a.todd@ru.ac.za or Cell: 0832770795

* Required

1. Consent Clause *

Check all that apply.

☐ By completing this questionnaire, I CONSENT to participating in this Masters research

Your General Biographical Information

Please answer the following questions as accurately as possible. Please note that the information you give will be treated in strictest confidence.

2. Age (years)

_____

3. Sex

Mark only one oval.

◯ Female
◯ Male
◯ Prefer not to say
◯ Other: _____

13. On average, how many hours do you work each week excluding overtime?

Please indicate in minutes and hours

_____

14. On average, how many hours paid overtime do you work each week?

Please indicate in hours and minutes

_____

15. On average, how many hours unpaid overtime do you work each week (e.g. over-run of shifts)?

Please indicate in hours and minutes

_____

16. Do you have a second paid job in addition to your main one?

Mark only one oval.

- ◯ Yes
- ◯ No

17. If you've taken a career break (or breaks), how long was this in total?

Please indicate in years and months.

_____

Your Shift Details	For each of the shifts that you normally work, at what time do they star and endt? If you do not work the specified shifts, just write N/a.

18. What time does your morning (or early) shift START?

_____

28. On average, how long does it take you to travel from work after a MORNING shift?

_____

29. On average, how long does it take you to travel to work on a AFTERNOON shift?

_____

30. On average, how long does it take you to travel from work after an AFTERNOON shift?

_____

31. On average, how long does it take you to travel to work NIGHT shift?

_____

32. On average, how long does it take you to travel from work after NIGHT shift?

_____

33. On average, how long does it take you to travel to work on a shift other than the above mentioned?
Please indicate the type of shift if "other"

_____

34. On average, how long does it take you to travel from work after a shift other than the above mentioned?
Please indicate the type of shift if "other"

_____

35. How do you normally travel to work?

Mark only one oval.

- Public transport
- Private transport
- Combination of private and public
- Company transport
- By foot

36. Do you ever feel unsafe when travelling to and from work on the following shift?

Mark only one oval per row.

	Almost never	Quite seldom	Quite often	Almost always
Morning				
Afternoon				
Night				
Other				

Shift arrangements

If you do not work a specific shift, write N/A

37. Number of successive morning shifts

_____

38. Number of successive afternoon shifts

_____

39. Number of successive night shifts

_____

40. Total number of successive shifts (of any kind) before days off

_____

41. Other shifts?

_____

42. What is the maximum number of shifts of any kind you have worked between days off in the past month?

_____

43. On average, how many days off in succession do you normally have?

_____

44. In general, when changing from one type of shift to another, what type of shift is each shift or day off followed by? MORNING shifts are normally followed by?

_____

45. MORNING shifts are normally followed by?

_____

46. AFTERNOON shifts are normally followed by?

_____

47. NIGHT shifts are normally followed by?

_____

48. Other (please specify) shift are normally followed by?

_____

_____

_____

_____

_____

49. On average, how many nights do you work per year?

_____

50. How are these night shifts organized?

PLEASE TICK THE ONE WHICH BEST DESCRIBES YOUR NIGHT WORK

Check all that apply.

- [ ] permanent night shift
- [ ] a single block of night duty per year
- [ ] occasional blocks of night duty per year
- [ ] one or two nights each month
- [ ] One or two nights each week

Other: [ ] _____

51. On average, how many weekends do you have off per 28 days?

_____

52. How regular is your shift system?
PLEASE TICK ONE

Mark only one oval.

- ◯ Regular (fixed roster that is repeated when the cycle of shifts finish, even if occasional variations occur)
- ◯ Irregular (duty roster does not cycle or repeat in a regular manner, and individual preferences are not taken into account)
- ◯ Flexible (where individual concerned are consulted about their preferred duty hours before the duty roster is drawn up)

53. If your shift system is regular, over how many weeks does the cycle run before it is repeated?

_____

54. To what extent do you feel you have control over specific shifts that you work?

Mark only one oval.

- ◯ None
- ◯ Not very much
- ◯ A fair amount
- ◯ Quite a lot
- ◯ Complete

55. To what extent do you feel you have control of the specific start and finish times of the shifts you work?

Mark only one oval.

- ◯ None
- ◯ Not very much
- ◯ A fair amount
- ◯ Quite a lot
- ◯ Complete

56. How much advance notice of your roster are you normally given?

IN WEEKS AND DAYS

_____

57. For each of the following, please indicate how often you:

Mark only one oval per row.

	Almost never	Rarely	Sometimes	Frequently	Almost always
Are required to change your roster at short notice	◯	◯	◯	◯	◯
Swop shifts with colleagues	◯	◯	◯	◯	◯
Make a request to work specific shifts	◯	◯	◯	◯	◯

58. Use the numbers 1-5 to rate your PHYSICAL workload in comparison to the average workload of other people performing a similar job in other parts of your organization:

Mark only one oval per row.

	1- extremely light	2- quite light	3- about the same	4- quite heavy	5- extremely heavy
Morning	◯	◯	◯	◯	◯
Afternoon	◯	◯	◯	◯	◯
Night	◯	◯	◯	◯	◯

59. Use the numbers 1-5 to rate your MENTAL workload in comparison to the average workload of other people performing a similar job in other parts of your organization:

Mark only one oval per row.

	1- extremely light	2- quite light	3- about the same	4- quite heavy	5- extremely heavy
Morning	◯	◯	◯	◯	◯
Afternoon	◯	◯	◯	◯	◯
Night	◯	◯	◯	◯	◯

60. Use the numbers 1-5 to rate your TIME PRESSURE in comparison to the average time pressure of other people performing a similar job in other parts of your organization:

Mark only one oval per row.

	1- extremely light	2- quite light	3- about the same	4- quite heavy	5- extremely heavy
Morning	◯	◯	◯	◯	◯
Afternoon	◯	◯	◯	◯	◯
Night	◯	◯	◯	◯	◯

61. Use the numbers 1-5 to rate your EMOTIONAL STRESS in comparison to the average emotional stress of other people performing a similar job in other parts of your organization:

Mark only one oval per row.

	1- extremely light	2- quite light	3- about the same	4- quite heavy	5- extremely heavy
Morning	◯	◯	◯	◯	◯
Afternoon	◯	◯	◯	◯	◯
Night	◯	◯	◯	◯	◯

62. What are you main reasons for working shifts

From 1 (not a reason for me) to 5 (very much a reason for me). If other, please specify in the next question

Mark only one oval per row.

	1- Not a reason for me	2	3- Partly a reason for	4	5- Very much a reason for me
It is part of the job	◯	◯	◯	◯	◯
It was the only job available	◯	◯	◯	◯	◯
More convenient for my domestic responsibilities	◯	◯	◯	◯	◯
Higher rates of pay	◯	◯	◯	◯	◯
Other (please specify in below)	◯	◯	◯	◯	◯

63. Any other reasons why you work shifts?

64. All other things being equal, would you prefer to give up working shifts and get a day-time job without shifts?

Mark only one oval.

- 1 - Definitely not
- 2 - Probably not
- 3 - Maybe
- 4 - Probably yes
- 5 - Definitely yes

65. What are the THREE main Advantages of your shift system for you?

66. What are the THREE main Disadvantages of you shift system for you?

67. Do you feel that overall the advantages of the shift system outweigh the disadvantages?

Mark only one oval.

- 1 - Definitely not
- 2 - Probably not
- 3 - Maybe
- 4 - Probably yes
- 5 - Definitely yes

If you were entirely free to chose the start and finish times of your shifts, what times would you choose?

If there is a shift that is not applicable to you, please respond with N/A.

68. What START time would you chose for MORNING shifts?

_____

69. What END time would you chose for MORNING shifts?

_____

70. What START time would you chose for AFTERNOON shifts?

_____

71. What END time would you chose for AFTERNOON shifts?

_____

72. What START time would you chose for NIGHT shifts?

_____

73. What END time would you chose for NIGHT shifts?

74. What START time would you chose for OTHER shifts?
If other, please specify the type of shift.

75. What END time would you chose for OTHER shifts?
If other, please specify the type of shift.

Your sleep and fatigue

These questions pertain to your sleep characteristics, and feelings of vigor and energy over the past few weeks. Please play attention to the descriptions of the questions as they have explanations to aid your answers.

76. On average, at what time do you normally fall asleep BEFORE your early morning shift?

77. On average, at what time do you normally wake up BEFORE your early morning shift?

78. On average, at what time do you normally fall asleep BEFORE your afternoon shift?

79. On average, at what time do you normally wake up AFTER your afternoon shift?

80. On average, at what time do you normally fall asleep BEFORE your night shift?

_____

81. On average, at what time do you normally wake up AFTER your night shift?

_____

82. On average, at what time do you normally fall asleep on DAYS OFF?

_____

83. On average, at what time do you normally wake up on DAYS OFF?

_____

84. If you normally take a nap/naps in addition to your main sleep, either at work or at home on MORNING shifts, what time to you take it/them
Please indicate as "from 14h00 to16h00" OR "14h00-16h00"

_____

85. If you normally take a nap/naps in addition to your main sleep, either at work or at home on AFTERNOON shifts, what time to you take it/them
Please indicate as "from 14h00 to16h00" OR "14h00-16h00"

_____

86. If you normally take a nap/naps in addition to your main sleep, either at work or at home on NIGHT shifts, what time to you take it/them
Please indicate as "from 14h00 to16h00" OR "14h00-16h00"

_____

87. If you normally take a nap/naps in addition to your main sleep, either at work or at home on DAYS OFF, what time to you take it/them

Please indicate as "from 14h00 to16h00" OR "14h00-16h00"

_____

88. How many hours sleep do you feel you usually need per day, irrespective of which shift you are on?

HOURS AND MINUTES

_____

89. How do you feel about the amount of sleep you normally get?

Mark only one oval per row.

	1 - nowhere enough	2 - could do with a lot more	3 - could do with a bit more	4 - get the right amount	5 - get plenty
Between successive morning shifts	◯	◯	◯	◯	◯
Between successive afternoon shifts	◯	◯	◯	◯	◯
Between successive night shifts	◯	◯	◯	◯	◯
Between days off	◯	◯	◯	◯	◯

90. How do you normally sleep?

Mark only one oval per row.

	1 - extremely badly	2 - quite badly	3 - moderately well	4 - quite well	5 - extremely well
Between successive morning shifts					
Between successive afternoon shifts					
Between successive night shifts					
Between days off					

91. How rested do you normally feel after sleep?

Mark only one oval per row.

	1 - definitely not rested	2 - not very rested	3 - moderately rested	4 - quite rested	5 - extremely rested
Between successive morning shifts					
Between successive afternoon shifts					
Between successive night shifts					
Between days off					

92. Do you ever wake up earlier than you intended?

Mark only one oval per row.

	1 - almost never	2 - rarely	3 - sometimes	4 - frequently	5 - almost always
Between successive morning shifts					
Between successive afternoon shifts					
Between successive night shifts					
Between days off					

93. Do you have difficulty in falling asleep?

Mark only one oval per row.

	1 - almost never	2 - rarely	3 - sometimes	4 - frequently	5 - almost always
Between successive morning shifts					
Between successive afternoon shifts					
Between successive night shifts					
Between days off					

94. Do you take sleeping pills?

Mark only one oval per row.

	1 - almost never	2 - rarely	3 - sometimes	4 - frequently	5 - almost always
Between successive morning shifts					
Between successive afternoon shifts					
Between successive night shifts					
Between days off					

95. Do you use alcohol to help you to sleep?

Mark only one oval per row.

	1 - almost never	2 - rarely	3 - sometimes	4 - frequently	5 - almost always
Between successive morning shifts					
Between successive afternoon shifts					
Between successive night shifts					
Between days off					

96. Do you ever feel tired on

Mark only one oval per row.

	1 - almost never	2 - rarely	3 - sometimes	4 - frequently	5 - almost always
Morning shifts	◯	◯	◯	◯	◯
Afternoon shifts	◯	◯	◯	◯	◯
Night shifts	◯	◯	◯	◯	◯
Days off	◯	◯	◯	◯	◯

97. The following items relate to how tired or energetic you feel, irrespective of whether you have had enough sleep or have been working very hard. Please indicate to which degree the following statements apply to your own normal feelings:

Mark only one oval per row.

	1 - Not at all	2 -	3 - somewhat	4 -	5 - very much so
I generally feel I have plenty of energy	◯	◯	◯	◯	◯
I usually feel drained	◯	◯	◯	◯	◯
I generally feel quite active	◯	◯	◯	◯	◯
I feel tired most of the time	◯	◯	◯	◯	◯
I generally feel full of vigour	◯	◯	◯	◯	◯
I usually feel rather lethargic	◯	◯	◯	◯	◯
I generally feel alert	◯	◯	◯	◯	◯
I often feel exhuasted	◯	◯	◯	◯	◯
I usually feel lively	◯	◯	◯	◯	◯
I feel weary much of the time	◯	◯	◯	◯	◯

98. Do you have any other comments or observations relation to your sleep and fatigue that have not been covered in the above section? If so, please try to describe them here:

_____

_____

_____

_____

_____

The type of person you are

Questions pertaining to preferences in time of day for activities, work, daily habits and preferences; and behaviours, feelings, and actions

99. Considering only your own 'feeling best' rhythm, at what time would you get up if you were entirely free to plan your day?

Mark only one oval.

- ◯ 05:00 - 06:30
- ◯ 06:30 - 07:45
- ◯ 07:45 - 09:45
- ◯ 09:45 - 11:00
- ◯ 11:00 - 12:00 (noon)

100. Considering only your own 'feeling best' rhythm, at what time would you go to bed if you were entirely free to plan your evening?

Mark only one oval.

- ◯ 20:00 - 21:00
- ◯ 21:00 - 22:15
- ◯ 22:15 - 00:30
- ◯ 00:30 - 01:45
- ◯ 01:45 - 03:00

101. Assuming normal circumstance, how easy do you find getting up in the morning?

Mark only one oval.

- Not at all easy
- Slightly easy
- Fairly easy
- Very easy

102. How alert do you feel during the first half hour after awakened in the morning?

Mark only one oval.

- Not at all alert
- Slightly alert
- Fairly alert
- Very alert

103. During the first half hour after having awakened in the morning, how tired do you feel?

Mark only one oval.

- Very tired
- Fairly tired
- Fairly refreshed
- very refreshed

104. You have decided to engage in some physical exercise. A friend suggests that you do this one hour twice a week and the best time for him is 07:00 - 08:00. Bearing in mind nothing else but your own 'feeling best' rhythm, how do you think you would perform?

Mark only one oval.

- ◯ Would be in good form
- ◯ Would be in reasonable form
- ◯ Would find it difficult
- ◯ Would find it very difficult

105. At what time in the evening do you feel tired and, as a result, in need of sleep

Mark only one oval.

- ◯ 20:00 - 21:00
- ◯ 21:00 - 22:12
- ◯ 22:15 - 00:30
- ◯ 00:30 - 01:45
- ◯ 01:45 - 03:00

106. You wish to be at your peak performance for a test which you know is going to be mentally exhausting and lasting for two hours. You are entirely free to plan your day, and considering your own 'feeling best' rhythm, which ONE of the four testing times would you choose?

Mark only one oval.

- ◯ 08:00 - 10:00
- ◯ 11:00 - 13:00
- ◯ 15:00 - 17:00
- ◯ 19:00 - 21:00

107. One hears about 'morning' and 'evening' types of people. Which ONE of these types do you consider yourself to be?

Mark only one oval.

- ◯ Definitely a morning type
- ◯ More a morning than an evening type
- ◯ More an evening than a morning type
- ◯ Definitely and evening type

108. When would you prefer to rise (provided you have a full day's work - 8 hours) if you were totally free to arrange your time?

Mark only one oval.

- ◯ Before 06:30
- ◯ 06:30 - 07:30
- ◯ 07:30 - 08:30
- ◯ 08:30 or later

109. If your had to rise at 06:00 what do you think it would be like?

Mark only one oval.

- ◯ Very difficult and unpleasant
- ◯ Rather difficult and unpleasant
- ◯ A little unpleasant but no great problem
- ◯ Easy and not unpleasant

110. How long a time does it usually take before you 'recover your senses' in the morning after rising from a night's sleep?

Mark only one oval.

- 0-10 minutes
- 11-20 minutes
- 21-40 minutes
- More than 40 minutes

111. Please indicate to what extent you are a morning or an evening ACTIVE individual?

Mark only one oval.

- Pronounced morning active (morning alert and evening tired)
- To some extent, morning active
- To some extent, evening active
- Pronounced evening active (morning tired and evening alert)

APPENDIX E - MAIN DATA COLLECTION

Determining the impact of shift work on nurses' sleep and fatigue in selected, private hospitals in the Eastern Cape.

Nurses are required to work in shifts, enduring physically and mentally demanding workloads, to provide 24-hour care to patients. Previous shift work research in healthcare has highlighted that nurses experience extended hours of wakefulness, reduced recovery, circadian desynchrony, changes in sleep/wake behaviours, which may contribute to poor sleep quality and insufficient sleep. Although there is ample research on sleep in healthcare, there is limited research available pertaining to how shift work impacts the South African, private nurse population.

Aims of the study

This study aims to determine the impact of shift work on nurses reported sleep and fatigue of selected, private healthcare nurses in the Eastern Cape through the use of an amended version of the Standard Shiftwork Index (SSI), a battery of questionnaires that explores the impact of shift work on sleep/wake behaviours, energy, physical and mental health, job satisfaction, changes in social and domestic life, and demographic information. For the purpose of this study, only questions pertaining to sleep, fatigue, time of day preference for activities, general demographic information, and your shift systems will be explored. Understanding the impact of different shift arrangements on nurse's reported sleep and fatigue is important, given the effects that sleepiness and fatigue may have on nurse alertness and performance when interacting during the care process. This study will also explore the impact of personal characteristics such as gender, age, work experience and number of children on your reported sleep and fatigue as a result of the shifts you work.

Due to the COVID-19 pandemic, we have made the questionnaire available online and as a hard copy to reduce contact sessions that may result in increased risk of infection.

If you choose to participate in this study, please answer EVERY QUESTION and pay particular attention to the descriptions of each question as they provide explanations to aid your answering. You are NOT required to provide your name, as your information will remain ANONYMOUS. If you choose to withdraw from the study at point during data collection, you have the right to do so without any consequences.

BY COMPLETING THIS QUESTIONNAIRE, YOU ARE CONSENTING TO PARTICIPATE IN THIS STUDY. Please tick the box in the consent clause below.

Please note that there are questions that may highlight various negative effects of shift work. If these outcomes concern you, especially the physical and mental health questions, after completing the questionnaire, please see your GENERAL PRACTITIONER, as we are not trained to give any clinical advice to participants.

After data collection, the information obtained from you will be stored and analyzed with confidentiality. Thereafter, the results of this study will be presented to the matron of the hospital and distributed among nurses using the most relevant.

Ethical clearance number:
1. Rhodes University - 2021-5040-6245
2. LHC HREC - 29092021/4
Ethics Committee coordinator: Siyanda Manqele
Email: ethics-committee@ru.ac.za

If you have any questions pertaining to this study, please contact:
EMMA BELL: Email: g16b3543@campus.ru.ac.za or Cell: 0764587713
JONATHAN DAVY: Email: j.davy@ru.ac.za or Cell: 072 226 0430
ANDREW TODD: Email: a.todd@ru.ac.za or Cell: 0832770795

* Required

1. Consent Clause *

Check all that apply.

☐ By completing this questionnaire, I CONSENT to participating in this Masters research

Your General Biographical Information

Please answer the following questions as accurately as possible. Please note that the information you give will be treated with the strictest confidence. However, if there are any particular questions you have regarding the questions asked or about shift work, please do feel free to contact the researchers at any time.

2. Age (years)

_____

3. Sex

Mark only one oval.

- ◯ Female
- ◯ Male
- ◯ Prefer not to say
- ◯ Other: _____

4. In terms of your marital status, are you

Mark only one oval.

- ◯ Married/living with a partner
- ◯ Separated/divorced
- ◯ Single
- ◯ Widowed

5. On average, how many hours per week does your partner work in paid employment?

_____

6. What is your partner's work pattern

IF OTHER, PLEASE SPECIFY NEXT TO IT

Mark only one oval.

- ◯ Daytime - no shifts
- ◯ Rotating shifts with nights
- ◯ Rotating shifts without nights
- ◯ Permanent nights
- ◯ Not applicable
- ◯ Other: _____

7. How does your partner feel about YOU working shifts?

Mark only one oval.

- ◯ Extremely unsupportive
- ◯ Fairly unsupportive
- ◯ Quite indifferent
- ◯ Fairly supportive
- ◯ Extremely supportive

8. How many persons in your household are in each of the following age groups? 0-5 years, 6-12 years, 13-18 years, 19-24 years, 25-60 years, and 60 + years.

Please include yourself.

Check all that apply.

	1	2	3	4	5	6	7	8
0 - 5	☐	☐	☐	☐	☐	☐	☐	☐
6 - 12	☐	☐	☐	☐	☐	☐	☐	☐
13 - 18	☐	☐	☐	☐	☐	☐	☐	☐
19 - 24	☐	☐	☐	☐	☐	☐	☐	☐
25 - 60	☐	☐	☐	☐	☐	☐	☐	☐
60 +	☐	☐	☐	☐	☐	☐	☐	☐

9. How many of these need looking after by YOU?

_____

10. What category of nurse do you fall under? *

For example: a registered nurse (RN)

_____

11. How long have you worked as a nurse?

This refers to the years you have worked as a nurse ALTOGETHER, including as a nursing student. Please indicate in years and months

_____

12. How long have you worked in your present shift system?

This refers to your current shift system that you are working. Please indicate in years and months

_____

13. How long altogether have you been working shifts?

I.e. from the time you started working hours that are not 7am-4pm (a typical 8-hour working day). Please indicate in years and months. This includes during your student years.

_____

14. On average, how many hours do you work each week excluding overtime?

Please indicate in hours and minutes. If your shift schedule cycle dictates the amount of hours worked per week, please give an estimated range (upper and lower averages from of each week) of hours worked i.e. 36-45 hours

_____

15. On average, how many hours paid overtime do you work each week?

Please indicate in hours and minutes.

_____

16. On average, how many hours unpaid overtime do you work each week (e.g. over-run of shifts)?

Please indicate in hours and minutes

_____

17. Do you have a second paid job in addition to your main one?

Mark only one oval.

- ◯ Yes
- ◯ No

18. If you've taken a career break (or breaks), how long was this in total?

Please indicate in years and months.

_____

Your Shift Details

For each of the shifts that you normally work, at what time do they start and end? If you do not work the specified shifts, just write N/a.
Please note that if you work 12 hour shifts starting at 06:00 or 07:00 am, it is considered an (early) morning shift.

19. What time does your morning (or early) shift START?

_____

20. What time does your morning (or early) shift END?

_____

21. What time does your afternoon (or late evening or swing) shift START?

_____

22. What time does your afternoon (or late evening or swing) shift END?

_____

23. What time does your Half-day shift START

_____

24. What time does your Half-day shift END?

_____

25. What time does your night shift START?

_____

26. What time does your night shift END?

_____

27. Other shifts?

_____

28. On average, how long does it take you to travel to work on a MORNING shift?

_____

29. On average, how long does it take you to travel from work after a MORNING shift?

_____

30. On average, how long does it take you to travel to work on a AFTERNOON shift?

_____

31. On average, how long does it take you to travel from work after an AFTERNOON shift?

_____

32. On average, how long does it take you to travel to work NIGHT shift?

_____

33. On average, how long does it take you to travel from work after NIGHT shift?

_____

34. On average, how long does it take you to travel to work on a shift other than the above mentioned?
Please indicate the type of shift if "other"

_____

35. On average, how long does it take you to travel from work after a shift other than the above mentioned?

36. How do you normally travel to work?

Please note that if you hire and pay for transport as a group of employees PUBLIC TRANSPORT and NOT a combination of private and public transport

Mark only one oval.

- ◯ Public transport
- ◯ Private transport
- ◯ Combination of private and public
- ◯ Company transport
- ◯ By foot

37. Do you ever feel unsafe when travelling to and from work on the following shift?

Mark only one oval per row.

	Almost never	Quite seldom	Quite often	Almost always
Morning	◯	◯	◯	◯
Afternoon	◯	◯	◯	◯
Night	◯	◯	◯	◯
Other	◯	◯	◯	◯

Shift arrangements

If you do not work a specific shift, write N/A

38. Number of morning shifts in a row

Successive - shifts that are worked one after the other with no days off in between. I.e. working a 12-hour shift today and tomorrow are successive shifts

39. Number of afternoon shifts in a row

40. Number of night shifts in a row

41. Total number of shifts (of any kind) in a row before days off

42. Other shifts?

_____

43. Maximum number of shifts of any kind you have worked between days off in the past month?

_____

44. On average, how many days off in a row do you normally have?

_____

In general, when changing from one type of shift to another, what type of shift is each shift or day off followed by?

45. MORNING shifts are normally followed by?

_____

46. AFTERNOON shifts are normally followed by?

_____

47. NIGHT shifts are normally followed by?

_____

48. Other (please specify) shift are normally followed by?

_____

_____

_____

_____

_____

49. On average, how many nights do you work per year?

_____

50. How are these night shifts organized?

PLEASE TICK THE ONE WHICH BEST DESCRIBES YOUR NIGHT WORK

Check all that apply.

- ☐ permanent night shift
- ☐ a single block of night duty per year
- ☐ occasional blocks of night duty per year
- ☐ one or two nights each month
- ☐ One or two nights each week

Other: ☐ _____

51. On average, how many weekends do you have off per 28 days?

_____

52. How regular is your shift system?
PLEASE TICK ONE - please note this question refers to your CURRENT shift system

Mark only one oval.

- ◯ Regular (fixed roster that is repeated when the cycle of shifts finish, even if occasional variations occur)
- ◯ Irregular (duty roster does not cycle or repeat in a regular manner, and individual preferences are not taken into account)
- ◯ Flexible (where individual concerned are consulted about their preferred duty hours before the duty roster is drawn up)

53. If your shift system is regular, over how many weeks does the cycle run before it is repeated?

_____

54. To what extent do you feel you have control over specific shifts that you work?

Mark only one oval.

- ◯ None
- ◯ Not very much
- ◯ A fair amount
- ◯ Quite a lot
- ◯ Complete

55. To what extent do you feel you have control of the specific start and finish times of the shifts you work?

Mark only one oval.

- ◯ None
- ◯ Not very much
- ◯ A fair amount
- ◯ Quite a lot
- ◯ Complete

56. How much advance notice of your roster are you normally given?
IN WEEKS AND DAYS

_____

57. For each of the following, please indicate how often you:

Mark only one oval per row.

	Almost never	Rarely	Sometimes	Frequently	Almost always
Are required to change your roster at short notice	◯	◯	◯	◯	◯
Swop shifts with colleagues	◯	◯	◯	◯	◯
Make a request to work specific shifts	◯	◯	◯	◯	◯

58. Use the numbers 1-5 to rate your PHYSICAL workload in comparison to the average workload of other people performing a similar job in other parts of your organization:

Mark only one oval per row.

	1- extremely light	2- quite light	3- about the same	4- quite heavy	5- extremely heavy
Morning	◯	◯	◯	◯	◯
Afternoon	◯	◯	◯	◯	◯
Night	◯	◯	◯	◯	◯

59. Use the numbers 1-5 to rate your MENTAL workload in comparison to the average workload of other people performing a similar job in other parts of your organization:

Please note that this is not emotional workload/stress. Mental workload refers to attention and mental resources needed for completing tasks

Mark only one oval per row.

	1- extremely light	2- quite light	3- about the same	4- quite heavy	5- extremely heavy
Morning	◯	◯	◯	◯	◯
Afternoon	◯	◯	◯	◯	◯
Night	◯	◯	◯	◯	◯

60. Use the numbers 1-5 to rate your TIME PRESSURE in comparison to the average time pressure of other people performing a similar job in other parts of your organization:

Mark only one oval per row.

	1- extremely light	2- quite light	3- about the same	4- quite heavy	5- extremely heavy
Morning	◯	◯	◯	◯	◯
Afternoon	◯	◯	◯	◯	◯
Night	◯	◯	◯	◯	◯

61. Use the numbers 1-5 to rate your EMOTIONAL STRESS in comparison to the average emotional stress of other people performing a similar job in other parts of your organization:

Please note that emotional stress refers to psychological strain and uneasiness triggered by a perceived threat in your daily life.

Mark only one oval per row.

	1- extremely light	2- quite light	3- about the same	4- quite heavy	5- extremely heavy
Morning	◯	◯	◯	◯	◯
Afternoon	◯	◯	◯	◯	◯
Night	◯	◯	◯	◯	◯

62. What are you main reasons for working shifts

From 1 (not a reason for me) to 5 (very much a reason for me). If other, please specify in the next question

Mark only one oval per row.

	1- Not a reason for me	2 - Less of a reason for me	3- Partly a reason for me	4 - More of a reason for me	5- Very much a reason for me
It is part of the job	◯	◯	◯	◯	◯
It was the only job available	◯	◯	◯	◯	◯
More convenient for my domestic responsibilities	◯	◯	◯	◯	◯
Higher rates of pay	◯	◯	◯	◯	◯
Other (please specify in below)	◯	◯	◯	◯	◯

63. Any other reasons why you work shifts?

64. All other things being equal, would you prefer to give up working shifts and get a day-time job without shifts?

Mark only one oval.

- ◯ 1 - Definitely not
- ◯ 2 - Probably not
- ◯ 3 - Maybe
- ◯ 4 - Probably yes
- ◯ 5 - Definitely yes

65. What are the THREE main Advantages of your shift system for you?

66. What are the THREE main Disadvantages of you shift system for you?

67. Do you feel that overall the advantages of the shift system outweigh the disadvantages?

Mark only one oval.

- 1 - Definitely not
- 2 - Probably not
- 3 - Maybe
- 4 - Probably yes
- 5 - Definitely yes

If you were entirely free to chose the start and finish times of your shifts, what times would you choose?

If there is a shift that is not applicable to you, please respond with N/A.

68. What START time would you chose for MORNING shifts?

69. What END time would you chose for MORNING shifts?

70. What START time would you chose for AFTERNOON shifts?

71. What END time would you chose for AFTERNOON shifts?

72. What START time would you chose for NIGHT shifts?

73. What END time would you chose for NIGHT shifts?

_____

74. What START time would you chose for OTHER shifts?
If other, please specify the type of shift.

_____

75. What END time would you chose for OTHER shifts?
If other, please specify the type of shift.

_____

Your sleep and fatigue

These questions pertain to your sleep characteristics, and feelings of vigor (effort and enthusiasm) and energy over the past few weeks. Please play attention to the descriptions of the questions as they have explanations to aid your answers.

76. On average, at what time do you normally fall asleep BEFORE your early morning shift?

_____

77. On average, at what time do you normally wake up BEFORE your early morning shift?

_____

78. On average, at what time do you normally fall asleep BEFORE your afternoon shift?

_____

79. On average, at what time do you normally wake up AFTER your afternoon shift?

_____

80. On average, at what time do you normally fall asleep BEFORE your night shift?

_____

81. On average, at what time do you normally wake up AFTER your night shift?

_____

82. On average, at what time do you normally fall asleep on DAYS OFF?

_____

83. On average, at what time do you normally wake up on DAYS OFF?

_____

84. If you normally take a nap/naps in addition to your main sleep, either at work or at home on MORNING shifts, what time to you take it/them
Please indicate as "from 14h00 to16h00" OR "14h00-16h00"

_____

85. If you normally take a nap/naps in addition to your main sleep, either at work or at home on AFTERNOON shifts, what time to you take it/them
Please indicate as "from 14h00 to16h00" OR "14h00-16h00"

_____

86. If you normally take a nap/naps in addition to your main sleep, either at work or at home on NIGHT shifts, what time to you take it/them
Please indicate as "from 14h00 to16h00" OR "14h00-16h00"

_____

87. If you normally take a nap/naps in addition to your main sleep, either at work or at home on DAYS OFF, what time to you take it/them
Please indicate as "from 14h00 to16h00" OR "14h00-16h00"

_____

88. How many hours sleep do you feel you usually need per day, irrespective of which shift you are on?
HOURS AND MINUTES

_____

89. How do you feel about the amount of sleep you normally get?

Mark only one oval per row.

	1 - nowhere enough	2 - could do with a lot more	3 - could do with a bit more	4 - get the right amount	5 - get plenty
Between successive morning shifts	◯	◯	◯	◯	◯
Between successive afternoon shifts	◯	◯	◯	◯	◯
Between successive night shifts	◯	◯	◯	◯	◯
Between days off	◯	◯	◯	◯	◯

90. How do you normally sleep?

Mark only one oval per row.

	1 - extremely badly	2 - quite badly	3 - moderately well	4 - quite well	5 - extremely well
Between successive morning shifts					
Between successive afternoon shifts					
Between successive night shifts					
Between days off					

91. How rested do you normally feel after sleep?

Mark only one oval per row.

	1 - definitely not rested	2 - not very rested	3 - moderately rested	4 - quite rested	5 - extremely rested
Between successive morning shifts					
Between successive afternoon shifts					
Between successive night shifts					
Between days off					

92. Do you ever wake up earlier than you intended?

Mark only one oval per row.

	1 - almost never	2 - rarely	3 - sometimes	4 - frequently	5 - almost always
Between successive morning shifts					
Between successive afternoon shifts					
Between successive night shifts					
Between days off					

93. Do you have difficulty in falling asleep?

Mark only one oval per row.

	1 - almost never	2 - rarely	3 - sometimes	4 - frequently	5 - almost always
Between successive morning shifts					
Between successive afternoon shifts					
Between successive night shifts					
Between days off					

94. Do you take sleeping pills?

Mark only one oval per row.

	1 - almost never	2 - rarely	3 - sometimes	4 - frequently	5 - almost always
Between successive morning shifts	◯	◯	◯	◯	◯
Between successive afternoon shifts	◯	◯	◯	◯	◯
Between successive night shifts	◯	◯	◯	◯	◯
Between days off	◯	◯	◯	◯	◯

95. Do you use alcohol to help you to sleep?

Mark only one oval per row.

	1 - almost never	2 - rarely	3 - sometimes	4 - frequently	5 - almost always
Between successive morning shifts	◯	◯	◯	◯	◯
Between successive afternoon shifts	◯	◯	◯	◯	◯
Between successive night shifts	◯	◯	◯	◯	◯
Between days off	◯	◯	◯	◯	◯

96. Do you ever feel tired on

Mark only one oval per row.

	1 - almost never	2 - rarely	3 - sometimes	4 - frequently	5 - almost always
Morning shifts	◯	◯	◯	◯	◯
Afternoon shifts	◯	◯	◯	◯	◯
Night shifts	◯	◯	◯	◯	◯
Days off	◯	◯	◯	◯	◯

97. The following items relate to how tired or energetic you feel, irrespective of whether you have had enough sleep or have been working very hard. Please indicate to which degree the following statements apply to your own normal feelings:

Mark only one oval per row.

	1 - Not at all	2 -	3 - somewhat	4 -	5 - very much so
I generally feel I have plenty of energy	◯	◯	◯	◯	◯
I usually feel drained	◯	◯	◯	◯	◯
I generally feel quite active	◯	◯	◯	◯	◯
I feel tired most of the time	◯	◯	◯	◯	◯
I generally feel full of vigour	◯	◯	◯	◯	◯
I usually feel rather lethargic	◯	◯	◯	◯	◯
I generally feel alert	◯	◯	◯	◯	◯
I often feel exhuasted	◯	◯	◯	◯	◯
I usually feel lively	◯	◯	◯	◯	◯
I feel weary much of the time	◯	◯	◯	◯	◯

98. Do you have any other comments or observations relation to your sleep and fatigue that have not been covered in the above section? If so, please try to describe them here:

The type of person you are

Questions pertaining to preferences in time of day for activities, work, daily habits and preferences; and behaviours, feelings, and actions

99. Considering only your own 'feeling best' rhythm, at what time would you get up if you were entirely free to plan your day?

Mark only one oval.

- ◯ 05:00 - 06:30
- ◯ 06:30 - 07:45
- ◯ 07:45 - 09:45
- ◯ 09:45 - 11:00
- ◯ 11:00 - 12:00 (noon)

100. Considering only your own 'feeling best' rhythm, at what time would you go to bed if you were entirely free to plan your evening?

Mark only one oval.

- 20:00 - 21:00
- 21:00 - 22:15
- 22:15 - 00:30
- 00:30 - 01:45
- 01:45 - 03:00

101. Assuming normal circumstance, how easy do you find getting up in the morning?

Mark only one oval.

- Not at all easy
- Slightly easy
- Fairly easy
- Very easy

102. How alert do you feel during the first half hour after awakened in the morning?

Mark only one oval.

- Not at all alert
- Slightly alert
- Fairly alert
- Very alert

103. During the first half hour after having awakened in the morning, how tired do you feel?

Mark only one oval.

- Very tired
- Fairly tired
- Fairly refreshed
- very refreshed

104. You have decided to engage in some physical exercise. A friend suggests that you do this one hour twice a week and the best time for him is 07:00 - 08:00. Bearing in mind nothing else but your own 'feeling best' rhythm, how do you think you would perform?

Mark only one oval.

- Would be in good form
- Would be in reasonable form
- Would find it difficult
- Would find it very difficult

105. At what time in the evening do you feel tired and, as a result, in need of sleep

Mark only one oval.

- ◯ 20:00 - 21:00
- ◯ 21:00 - 22:12
- ◯ 22:15 - 00:30
- ◯ 00:30 - 01:45
- ◯ 01:45 - 03:00

106. You wish to be at your peak performance for a test which you know is going to be mentally exhausting and lasting for two hours. You are entirely free to plan your day, and considering your own 'feeling best' rhythm, which ONE of the four testing times would you choose?

Mark only one oval.

- ◯ 08:00 - 10:00
- ◯ 11:00 - 13:00
- ◯ 15:00 - 17:00
- ◯ 19:00 - 21:00

107. One hears about 'morning' and 'evening' types of people. Which ONE of these types do you consider yourself to be?

Mark only one oval.

- ◯ Definitely a morning type
- ◯ More a morning than an evening type
- ◯ More an evening than a morning type
- ◯ Definitely and evening type

108. When would you prefer to rise (provided you have a full day's work - 8 hours) if you were totally free to arrange your time?

Mark only one oval.

- ◯ Before 06:30
- ◯ 06:30 - 07:30
- ◯ 07:30 - 08:30
- ◯ 08:30 or later

109. If your had to rise at 06:00 what do you think it would be like?

Mark only one oval.

- ◯ Very difficult and unpleasant
- ◯ Rather difficult and unpleasant
- ◯ A little unpleasant but no great problem
- ◯ Easy and not unpleasant

110. How long a time does it usually take before you 'recover your senses' in the morning after rising from a night's sleep?

Mark only one oval.

- 0-10 minutes
- 11-20 minutes
- 21-40 minutes
- More than 40 minutes

111. Please indicate to what extent you are a morning or an evening ACTIVE individual?

Mark only one oval.

- Pronounced morning active (morning alert and evening tired)
- To some extent, morning active
- To some extent, evening active
- Pronounced evening active (morning tired and evening alert)

APPENDIX F – STATISATICAL ANALYSIS - KRUSKAL-WALLIS

A comparison of age across the three different shift arrangements.

Depend.: Age	Kruskal-Wallis ANOVA by Ranks; Age Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 50) =.1778925 p =.9149			
	Code	Valid N	Sum of Ranks	Mean Rank
1	1	19	493.0000	25.94737
2	2	13	312.5000	24.03846
3	3	18	469.5000	26.08333

A comparison of sex across the three different shift arrangements.

Depend.: Sex	Kruskal-Wallis ANOVA by Ranks; Sex Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 51) =3.411093 p =.1817			
	Code	Valid N	Sum of Ranks	Mean Rank
1	1	20	495.5000	24.77500
2	2	13	382.0000	29.38462
3	3	18	448.5000	24.91667

A comparison of marital status the three different shift arrangements.

Depend.: Marital status	Kruskal-Wallis ANOVA by Ranks; Marital status Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 51) =4.341779 p =.1141			
	Code	Valid N	Sum of Ranks	Mean Rank
1	1	20	612.0000	30.60000
2	2	13	324.5000	24.96154
3	3	18	389.5000	21.63889

A comparison of nurse category across the three different shift arrangements.

Depend.: Nurse Category	Kruskal-Wallis ANOVA by Ranks; Nurse Category Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 51) =.8411342 p =.6567			
	Code	Valid N	Sum of Ranks	Mean Rank
1	1	20	520.0000	26.00000
2	2	13	368.0000	28.30769
3	3	18	438.0000	24.33333

A comparison of shift regularity across the three different shift arrangements.

Depend.: Regular shift system?	Kruskal-Wallis ANOVA by Ranks; Regular shift system Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 50) =6.236066 p =.0442			
	Code	Valid N	Sum of Ranks	Mean Rank
1	1	20	562.0000	28.10000
2	2	13	364.5000	28.03846
3	3	17	348.5000	20.50000

A comparison of nurses' partners' working hours across the three different shift arrangements.

Depend.: Partner Hours (H)	Kruskal-Wallis ANOVA by Ranks; Partner Hours (H) Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 21) =.4802120 p =.7865			
	Code	Valid N	Sum of Ranks	Mean Rank
1	1	4	51.0000	12.75000
2	2	5	55.5000	11.10000
3	3	12	124.5000	10.37500

A comparison of nurses' partners' shift patterns across the three different shift arrangements.

Depend.: Partner work pattern	Kruskal-Wallis ANOVA by Ranks; Partner work pattern Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 24) =.9917321 p =.6090			
	Code	Valid N	Sum of Ranks	Mean Rank
1	1	7	92.0000	13.14286
2	2	5	72.0000	14.40000
3	3	12	136.0000	11.33333

A comparison of nurses' partners' perceptions of nurses working shifts across the three different shift arrangements.

Depend.: Partner feels towards your shifts	Kruskal-Wallis ANOVA by Ranks; Partner feels towards your shifts Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 31) =1.513508 p =.4692			
	Code	Valid N	Sum of Ranks	Mean Rank
1	1	10	176.0000	17.60000
2	2	8	104.5000	13.06250
3	3	13	215.5000	16.57692

A comparison of household dependents that need looking after by the nurses across the three different shift arrangements.

Depend.: Household dependents looked after by you	Kruskal-Wallis ANOVA by Ranks; Household dependents looked after by you Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 43) =5.546457 p =.0625			
	Code	Valid N	Sum of Ranks	Mean Rank
1	1	19	451.0000	23.73684
2	2	9	249.0000	27.66667
3	3	15	246.0000	16.40000

A comparison of nurses' overall nursing experience across the three different shift arrangements.

Depend.: How long worked as a nurse (Y)	Kruskal-Wallis ANOVA by Ranks; How long worked as a nurse (Y) Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 51) =2.578883 p =.2754			
	Code	Valid N	Sum of Ranks	Mean Rank
1	1	20	452.5000	22.62500
2	2	13	328.0000	25.23077
3	3	18	545.5000	30.30556

A comparison of nurses' experience working in their present shift systems across the three different shift arrangements.

Depend.: How long working in present shift system (Y)	Kruskal-Wallis ANOVA by Ranks; How long working in present shift system (Y) Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 50) =5.458378 p =.0653			
	Code	Valid N	Sum of Ranks	Mean Rank
1	1	19	368.5000	19.39474
2	2	13	369.5000	28.42308
3	3	18	537.0000	29.83333

A comparison of nurses' overall experience working shifts across the three different shift arrangements.

Depend.: How long working shifts altogether (Y)	Kruskal-Wallis ANOVA by Ranks; How long working shifts altogether (Y) Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 48) =.7243101 p =.6962			
	Code	Valid N	Sum of Ranks	Mean Rank
1	1	19	436.0000	22.94737
2	2	13	310.0000	23.84615
3	3	16	430.0000	26.87500

A comparison of nurses' average working hours (excluding overtime) across the three different shift arrangements.

Depend.: Average working hours excluding overtime (H)	Kruskal-Wallis ANOVA by Ranks; Average working hours excluding overtime (H) Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 49) =5.211523 p =.0738			
	Code	Valid N	Sum of Ranks	Mean Rank
1	1	20	589.0000	29.45000
2	2	12	213.5000	17.79167
3	3	17	422.5000	24.85294

A comparison of nurses' average hours of paid overtime across the three different shift arrangements.

Depend.: Average hours of paid overtime p/w (H)	Kruskal-Wallis ANOVA by Ranks; Average hours of paid overtime p/w (H) Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 38) =1.819589 p =.4026			
	Code	Valid N	Sum of Ranks	Mean Rank
1	1	17	352.0000	20.70588
2	2	8	177.0000	22.12500
3	3	13	212.0000	16.30769

A comparison of nurses' average, unpaid overtime hours across the three different shift arrangements.

Depend.: Average hours unpaid overtime p/w (H)	Kruskal-Wallis ANOVA by Ranks; Average hours unpaid overtime p/w (H) Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 16) =1.283245 p =.5264			
	Code	Valid N	Sum of Ranks	Mean Rank
1	1	3	30.50000	10.16667
2	2	4	39.50000	9.87500
3	3	9	66.00000	7.33333

A comparison of nurses working a second paid job across the three different shift arrangements.

Depend.: Second paid job	Kruskal-Wallis ANOVA by Ranks; Second paid job Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 51) =2.181164 p =.3360			
	Code	Valid N	Sum of Ranks	Mean Rank
1	1	20	472.5000	23.62500
2	2	13	364.5000	28.03846
3	3	18	489.0000	27.16667

A comparison of nurses' length of career break across the three different shift arrangements.

Depend.: Length of career break (Y)	Kruskal-Wallis ANOVA by Ranks; Length of career break (Y) Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 26) =4.163720 p =.1247			
	Code	Valid N	Sum of Ranks	Mean Rank
1	1	10	100.5000	10.05000
2	2	6	106.5000	17.75000
3	3	10	144.0000	14.40000

A comparison of nurses' mode of transport used across the three different shift arrangements.

Depend.: Mode of transport	Kruskal-Wallis ANOVA by Ranks; Mode of transport Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 51) =10.49287 p =.0053			
	Code	Valid N	Sum of Ranks	Mean Rank
1	1	20	654.0000	32.70000
2	2	13	234.0000	18.00000
3	3	18	438.0000	24.33333

A comparison of the total number of shifts worked before a day off across the three different shift arrangements.

Depend.: Total no successive shifts before day off	Kruskal-Wallis ANOVA by Ranks; Total no successive shifts before day off Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 34) =10.66655 p =.0048			
	Code	Valid N	Sum of Ranks	Mean Rank
1	1	11	279.5000	25.40909
2	2	10	129.0000	12.90000
3	3	13	186.5000	14.34615

A comparison of the maximum number of shifts worked before days off in the past month across the three different shift arrangements.

Depend.: Max no shifts before days off in the past month	Kruskal-Wallis ANOVA by Ranks; Max no shifts before days off in the past month Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 22) =.5507147 p =.7593			
	Code	Valid N	Sum of Ranks	Mean Rank
1	1	6	79.0000	13.16667
2	2	10	109.0000	10.90000
3	3	6	65.0000	10.83333

A comparison of the average number of successive days off across the three different shift arrangements.

Depend.: Average no of successive days off	Kruskal-Wallis ANOVA by Ranks; Average no of successive days off Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 47) =10.83326 p =.0044			
	Code	Valid N	Sum of Ranks	Mean Rank
1	1	18	564.0000	31.33333
2	2	12	280.0000	23.33333
3	3	17	284.0000	16.70588

A comparison of the weekends off per 28 days across the three different shift arrangements.

Depend.: Weekends off p/28 days	Kruskal-Wallis ANOVA by Ranks; Weekends off p/28 days Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 47) =5.955067 p =.0509			
	Code	Valid N	Sum of Ranks	Mean Rank
1	1	20	396.0000	19.80000
2	2	11	297.5000	27.04545
3	3	16	434.5000	27.15625

A comparison of how regular nurses' shift cycle is in weeks across the three different shift arrangements.

Depend.: Regular shift cycle in weeks	Kruskal-Wallis ANOVA by Ranks; Regular shift cycle in weeks Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 34) =3.600018 p =.1653			
	Code	Valid N	Sum of Ranks	Mean Rank
1	1	13	182.0000	14.00000
2	2	9	192.0000	21.33333
3	3	12	221.0000	18.41667

A comparison of nurses' perception of control over their shift system across the three different shift arrangements.

Depend.: Control of shift system	Kruskal-Wallis ANOVA by Ranks; Control of shift system Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 50) =1.903430 p =.3861			
	Code	Valid N	Sum of Ranks	Mean Rank
1	1	20	542.0000	27.10000
2	2	13	270.5000	20.80769
3	3	17	462.5000	27.20588

A comparison of nurses' perception of control over the start and end times of shifts across the three different shift arrangements.

Depend.: Control of start & end times	Kruskal-Wallis ANOVA by Ranks; Control of start & end times Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 50) =.4095693 p =.8148			
	Code	Valid N	Sum of Ranks	Mean Rank
1	1	20	540.0000	27.00000
2	2	13	312.0000	24.00000
3	3	17	423.0000	24.88235

A comparison of the days of notice given for nurses' rosters across the three different shift arrangements.

Depend.: Notice of roster (days)	Kruskal-Wallis ANOVA by Ranks; Notice of roster (days) Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 37) =.2041198 p =.9030			
	Code	Valid N	Sum of Ranks	Mean Rank
1	1	16	297.5000	18.59375
2	2	9	164.5000	18.27778
3	3	12	241.0000	20.08333

A comparison of how often nurses' are required to change their roster on short notice across the three different shift arrangements.

Depend.: required to change roster	Kruskal-Wallis ANOVA by Ranks; required to change roster Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 48) =9.318380 p =.0095			
	Code	Valid N	Sum of Ranks	Mean Rank
1	1	18	365.5000	20.30556
2	2	13	443.5000	34.11538
3	3	17	367.0000	21.58824

A comparison of how often nurses are required to swop shifts with colleagues across the three different shift arrangements.

Depend.: Swop shifts with colleagues	Kruskal-Wallis ANOVA by Ranks; Swop shifts with colleagues Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 48) =6.957260 p =.0309			
	Code	Valid N	Sum of Ranks	Mean Rank
1	1	18	416.5000	23.13889
2	2	13	420.0000	32.30769
3	3	17	339.5000	19.97059

A comparison of how often nurses can request to work specific shifts across the three different shift arrangements.

Depend.: request to work specific shifts	Kruskal-Wallis ANOVA by Ranks; request to work specific shifts Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 47) =6.996808 p =.0302			
	Code	Valid N	Sum of Ranks	Mean Rank
1	1	18	427.0000	23.72222
2	2	12	378.0000	31.50000
3	3	17	323.0000	19.00000

A comparison of whether nurses' advantages of their shift systems outweigh the disadvantages, across the three different shift arrangements.

Depend.: advantages outweigh disadvantages	Kruskal-Wallis ANOVA by Ranks; advantages outweigh disadvantages (Re-reduced) Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 49) =1.373826 p =.5031			
	Code	Valid N	Sum of Ranks	Mean Rank
1	1	20	538.5000	26.92500
2	2	12	253.5000	21.12500
3	3	17	433.0000	25.47059

A comparison of nurses wanting to quit working shifts to pursue a day job without shifts across the three different shift arrangements.

Depend.: Other things being equal would you give up shifts to work days	Kruskal-Wallis ANOVA by Ranks; Other things being equal would you give up shifts to work days Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 48) =12.45660 p =.0020			
	Code	Valid N	Sum of Ranks	Mean Rank
1	1	20	344.5000	17.22500
2	2	13	327.0000	25.15385
3	3	15	504.5000	33.63333

Multiple comparisons – KW

A multiple comparisons test to determine the significant differences are for age between the three different shift arrangements.

	Multiple Comparisons p values (2-tailed); Age Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 50) =.1778925 p =.9149		
Depend.: Age	1 R:25.947	2 R:24.038	3 R:26.083
1		1.000000	1.000000
2	1.000000		1.000000
3	1.000000	1.000000	

A multiple comparisons test to determine the significant differences are for age between the three different shift arrangements.

Depend.: Sex	Multiple Comparisons p values (2-tailed); Sex Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 51) =3.411093 p =.1817		
	1 R:24.775	2 R:29.385	3 R:24.917
1		1.000000	1.000000
2	1.000000		1.000000
3	1.000000	1.000000	

A multiple comparisons test to determine the significant differences are for sex between the three different shift arrangements.

Depend.: Marital status	Multiple Comparisons p values (2-tailed); Marital status Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 51) =4.341779 p =.1141		
	1 R:30.600	2 R:24.962	3 R:21.639
1		0.861145	0.190640
2	0.861145		1.000000
3	0.190640	1.000000	

A multiple comparisons test to determine the significant differences are for nurse category between the three different shift arrangements.

Depend.: Nurse Category	Multiple Comparisons p values (2-tailed); Nurse Category Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 51) =.8411342 p =.6567		
	1 R:26.000	2 R:28.308	3 R:24.333
1		1.000000	1.000000
2	1.000000		1.000000
3	1.000000	1.000000	

A multiple comparisons test to determine the significant differences are for shift regularity between the three different shift arrangements.

Depend.: Regular shift system?	Multiple Comparisons p values (2-tailed); Regular shift system Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 50) =6.236066 p =.0442		
	1 R:28.100	2 R:28.038	3 R:20.500
1		1.000000	0.342032
2	1.000000		0.481327
3	0.342032	0.481327	

A multiple comparisons test to determine the significant differences are for nurses' partners' working hours between the three different shift arrangements.

Depend.: Partner Hours (H)	Multiple Comparisons p values (2-tailed); Partner Hours (H) Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 21) =.4802120 p =.7865		
	1 R:12.750	2 R:11.100	3 R:10.375
1		1.000000	1.000000
2	1.000000		1.000000
3	1.000000	1.000000	

A multiple comparisons test to determine the significant differences are for Nurses' partners' work pattern between the three different shift arrangements.

Depend.: Partner work pattern	Multiple Comparisons p values (2-tailed); Partner work pattern Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 24) =.9917321 p =.6090		
	1 R:13.143	2 R:14.400	3 R:11.333
1		1.000000	1.000000
2	1.000000		1.000000
3	1.000000	1.000000	

A multiple comparisons test to determine the significant differences are for nurses' partners' perception of nurses working shifts between the three different shift arrangements.

Depend.: Partner feels towards your shifts	Multiple Comparisons p values (2-tailed); Partner feels towards your shifts Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 31) =1.513508 p =.4692		
	1 R:17.600	2 R:13.063	3 R:16.577
1		0.878251	1.000000
2	0.878251		1.000000
3	1.000000	1.000000	

A multiple comparisons test to determine the significant differences are for household dependents that need looking after by nurses between the three different shift arrangements.

Depend.: Household dependents looked after by you	Multiple Comparisons p values (2-tailed); Household dependents looked after by you Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 43) =5.546457 p =.0625		
	1 R:23.737	2 R:27.667	3 R:16.400
1		1.000000	0.272112
2	1.000000		0.099993
3	0.272112	0.099993	

A multiple comparisons test to determine the significant differences are for overall nursing experience between the three different shift arrangements.

Depend.: How long worked as a nurse (Y)	Multiple Comparisons p values (2-tailed); How long worked as a nurse (Y) Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 51) =2.578883 p =.2754		
	1 R:22.625	2 R:25.231	3 R:30.306
1		1.000000	0.335359
2	1.000000		1.000000
3	0.335359	1.000000	

A multiple comparisons test to determine the significant differences are for nurses' experience working in the present shift system between the three different shift arrangements.

Depend.: How long working in present shift system (Y)	Multiple Comparisons p values (2-tailed); How long working in present shift system (Y) Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 50) =5.458378 p =.0653		
	1 R:19.395	2 R:28.423	3 R:29.833
1		0.255923	0.088423
2	0.255923		1.000000
3	0.088423	1.000000	

A multiple comparisons test to determine the significant differences are for nurses' experience working shifts overall between the three different shift arrangements.

Depend.: How long working shifts altogether (Y)	Multiple Comparisons p values (2-tailed); How long working shifts altogether (Y) Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 48) =.7243101 p =.6962		
	1 R:22.947	2 R:23.846	3 R:26.875
1		1.000000	1.000000
2	1.000000		1.000000
3	1.000000	1.000000	

A multiple comparisons test to determine the significant differences are for nurses' average working hours excluding overtime between the three different shift arrangements.

Depend.: Average working hours excluding overtime (H)	Multiple Comparisons p values (2-tailed); Average working hours excluding overtime (H) Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 49) =5.211523 p =.0738		
	1 R:29.450	2 R:17.792	3 R:24.853
1		0.076356	0.988274
2	0.076356		0.569867
3	0.988274	0.569867	

A multiple comparisons test to determine the significant differences are for nurses' average hours of paid overtime between the three different shift arrangements.

Depend.: Average hours of paid overtime p/w (H)	Multiple Comparisons p values (2-tailed); Average hours of paid overtime p/w (H) Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 38) =1.819589 p =.4026		
	1 R:20.706	2 R:22.125	3 R:16.308
1		1.000000	0.848230
2	1.000000		0.732156
3	0.848230	0.732156	

A multiple comparisons test to determine the significant differences are for nurses' average hours of unpaid overtime between the three different shift arrangements.

Depend.: Average hours unpaid overtime p/w (H)	Multiple Comparisons p values (2-tailed); Average hours unpaid overtime p/w (H) Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 16) =1.283245 p =.5264		
	1 R:10.167	2 R:9.8750	3 R:7.3333
1		1.000000	1.000000
2	1.000000		1.000000
3	1.000000	1.000000	

A multiple comparisons test to determine the significant differences are for nurses' working a second paid job between the three different shift arrangements.

Depend.: Second paid job	Multiple Comparisons p values (2-tailed); Second paid job Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 51) =2.181164 p =.3360		
	1 R:23.625	2 R:28.038	3 R:27.167
1		1.000000	1.000000
2	1.000000		1.000000
3	1.000000	1.000000	

A multiple comparisons test to determine the significant differences are for nurses' length of career break between the three different shift arrangements.

Depend.: Length of career break (Y)	Multiple Comparisons p values (2-tailed); Length of career break (Y) Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 26) =4.163720 p =.1247		
	1 R:10.050	2 R:17.750	3 R:14.400
1		0.153699	0.610403
2	0.153699		1.000000
3	0.610403	1.000000	

A multiple comparisons test to determine the significant differences are for mode of transport used by nurses between the three different shift arrangements.

Depend.: Mode of transport	Multiple Comparisons p values (2-tailed); Mode of transport Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 51) =10.49287 p =.0053		
	1 R:32.700	2 R:18.000	3 R:24.333
1		0.016532	0.249676
2	0.016532		0.725426
3	0.249676	0.725426	

A multiple comparisons test to determine the significant differences are for total number of successive shifts worked before days off between the three different shift arrangements.

Depend.: Total no successive shifts before day off	Multiple Comparisons p values (2-tailed); Total no successive shifts before day off (Re-reduced) Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 34) =10.66655 p =.0048		
	1 R:25.409	2 R:12.900	3 R:14.346
1		0.012123	0.020079
2	0.012123		1.000000
3	0.020079	1.000000	

A multiple comparisons test to determine the significant differences are for the maximum number of days worked before days off in the past month between the three different shift arrangements.

Depend.: Max no shifts before days off in the past month	Multiple Comparisons p values (2-tailed); Max no shifts before days off in the past month (Re-reduced) Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 22) =.5507147 p =.7593		
	1 R:13.167	2 R:10.900	3 R:10.833
1		1.000000	1.000000
2	1.000000		1.000000
3	1.000000	1.000000	

A multiple comparisons test to determine the significant differences are for average number of successive days off between the three different shift arrangements.

Depend.: Average no of successive days off	Multiple Comparisons p values (2-tailed); Average no of successive days off (Re-reduced) Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 47) =10.83326 p =.0044		
	1 R:31.333	2 R:23.333	3 R:16.706
1		0.352336	0.004825
2	0.352336		0.599541
3	0.004825	0.599541	

A multiple comparisons test to determine the significant differences are for weekends off per 28 days between the three different shift arrangements.

Depend.: Weekends off p/28 days	Multiple Comparisons p values (2-tailed); Weekends off p/28 days Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 47) =5.955067 p =.0509		
	1 R:19.800	2 R:27.045	3 R:27.156
1		0.477639	0.329087
2	0.477639		1.000000
3	0.329087	1.000000	

A multiple comparisons test to determine the significant differences are for regular shift cycle in weeks between the three different shift arrangements.

Depend.: Regular shift cycle in weeks	Multiple Comparisons p values (2-tailed); Regular shift cycle in weeks Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 34) =3.600018 p =.1653		
	1 R:14.000	2 R:21.333	3 R:18.417
1		0.268385	0.803703
2	0.268385		1.000000
3	0.803703	1.000000	

A multiple comparisons test to determine the significant differences are for nurses' perception of control over the shift system between the three different shift arrangements.

Depend.: Control of shift system	Multiple Comparisons p values (2-tailed); Control of shift system Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 50) =1.903430 p =.3861		
	1 R:27.100	2 R:20.808	3 R:27.206
1		0.676994	1.000000
2	0.676994		0.700633
3	1.000000	0.700633	

A multiple comparisons test to determine the significant differences are for nurses perception of control over the start and end times between the three different shift arrangements.

Depend.: Control of start & end times	Multiple Comparisons p values (2-tailed); Control of start & end times Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 50) =.4095693 p =.8148		
	1 R:27.000	2 R:24.000	3 R:24.882
1		1.000000	1.000000
2	1.000000		1.000000
3	1.000000	1.000000	

A multiple comparisons test to determine the significant differences are for the notice of roster between the three different shift arrangements.

Depend.: Notice of roster (days)	Multiple Comparisons p values (2-tailed); Notice of roster (days) Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 37) =.2041198 p =.9030		
	1 R:18.594	2 R:18.278	3 R:20.083
1		1.000000	1.000000
2	1.000000		1.000000
3	1.000000	1.000000	

A multiple comparisons test to determine the significant differences are for how often nurses' are required to change their roster on short notice between the three different shift arrangements.

Depend.: required to change roster	Multiple Comparisons p values (2-tailed); required to change roster on short notice Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 48) =9.318380 p =.0095		
	1 R:20.306	2 R:34.115	3 R:21.588
1		0.020178	1.000000
2	0.020178		0.045469
3	1.000000	0.045469	

A multiple comparisons test to determine the significant differences are for how often nurses are required to swop shifts with colleagues between the three different shift arrangements.

Depend.: Swop shifts with colleagues	Multiple Comparisons p values (2-tailed); Swop shifts with colleagues Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 48) =6.957260 p =.0309		
	1 R:23.139	2 R:32.308	3 R:19.971
1		0.215898	1.000000
2	0.215898		0.050301
3	1.000000	0.050301	

A multiple comparisons test to determine the significant differences are for how often nurses can request to work specific shifts between the three different shift arrangements.

Depend.: request to work specific shifts	Multiple Comparisons p values (2-tailed); request to work specific shifts Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 47) =6.996808 p =.0302		
	1 R:23.722	2 R:31.500	3 R:19.000
1		0.383953	0.925545
2	0.383953		0.046825
3	0.925545	0.046825	

A multiple comparisons test to determine the significant differences are for nurses' giving up shifts to work a day job without shifts, between the three different shift arrangements.

Depend.: Other things being equal would you give up shifts to work days DN-1 PN -2 M-3 PY-4 DY-5	Multiple Comparisons p values (2-tailed); Other things being equal would you give up shifts to work days DN-1 PN -2 M-3 PY-4 DY-5 (Re-reduced) Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 48) =12.45660 p =.0020		
	1 R:17.225	2 R:25.154	3 R:33.633
1		0.335716	0.001802
2	0.335716		0.329876
3	0.001802	0.329876	

A multiple comparisons test to determine the significant differences are for nurses' perception of the advantages of their shift system outweighing the disadvantages, between the three different shift arrangements.

Depend.: advantages outweigh disadvantages	Multiple Comparisons p values (2-tailed); advantages outweigh disadvantages (Re-reduced) Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 49) =1.373826 p =.5031		
	1 R:26.925	2 R:21.125	3 R:25.471
1		0.798872	1.000000
2	0.798872		1.000000
3	1.000000	1.000000	

A multiple comparisons test to determine the significant differences are for nurses' sleep disturbances on days off, between the three different shift arrangements.

Depend.: Days off	Multiple Comparisons p values (2-tailed); Days off (Rotating TSDS redone for stats) Independent (grouping) variable: Shift organisation Kruskal-Wallis test: H (2, N= 40) =6.018776 p =.0493		
	1 R:17.156	2 R:27.375	3 R:18.083
1		0.066245	1.000000
2	0.066245		0.154649
3	1.000000	0.154649	

APPENDIX G - MANN-WHITNEY U TESTS

A comparison of variables for permanent day nurses and rotating nurses working day shifts only.

variable	Mann-Whitney U Test (w/ continuity correction) By variable Day x Rotating Marked tests are significant at p <.05000									
	Rank Sum Group 1	Rank Sum Group 2	U	Z	p-value	Z adjusted	p-value	Valid N Group 1	Valid N Group 2	2*1sided exact p
Travel time to day shift (MIN)	285.5000	210.5000	114.5000	-0.08006	0.936186	-0.08075	0.935640	18	13	0.921488
Travel time from day shift (MIN)	209.0000	169.0000	73.0000	-0.71552	0.474287	-0.72262	0.469916	16	11	0.480871
Do you feel unsafe travelling to/from day	256.0000	179.0000	85.0000	-0.60678	0.543997	-0.77156	0.440374	18	11	0.550075
No. successive day shifts	234.5000	116.5000	50.5000	1.63485	0.102082	1.67273	0.094381	15	11	0.097262
Total no successive shifts before day off	163.0000	113.0000	58.0000	0.40311	0.686865	0.41027	0.681608	13	10	0.692607
Max no shifts before days off in the past month	51.0000	85.0000	30.0000	-0.05423	0.956750	-0.05468	0.956396	6	10	1.000000
Average no of successive days off	222.0000	213.0000	69.0000	-1.43912	0.150116	-1.57703	0.114791	17	12	0.152277
Physical workload day	257.0000	178.0000	100.0000	0.06642	0.947043	0.07176	0.942790	17	12	0.947908
Mental workload day	256.5000	178.5000	100.5000	0.04428	0.964681	0.04793	0.961770	17	12	0.947908
Time pressure day	250.0000	185.0000	97.0000	-0.19926	0.842057	-0.22522	0.821806	17	12	0.844577
Emotional stress day	255.5000	179.5000	101.5000	0.00000	1.000000	0.00000	1.000000	17	12	0.982624
Choose start time day	203.5000	147.5000	81.5000	0.02595	0.979297	0.02761	0.977970	15	11	0.959358
Choose end time day	139.0000	92.0000	47.0000	0.46193	0.644128	0.47057	0.637948	12	9	0.651053
Fall asleep before day	211.0000	167.0000	89.0000	0.02440	0.980536	0.02565	0.979540	15	12	0.980869
wake up before day	244.0000	134.0000	56.0000	1.63463	0.102127	1.65886	0.097145	15	12	0.102800
Sleep duration Day	188.0000	137.0000	59.0000	1.00627	0.314288	1.02805	0.303928	13	12	0.320322
Fall asleep on days off	177.0000	148.0000	70.0000	0.40795	0.683313	0.41470	0.678362	13	12	0.688522
wake up on days off	164.5000	213.5000	59.5000	-1.50431	0.132502	-1.51171	0.130608	14	13	0.127859
Sleep duration Days off	127.5000	172.5000	36.5000	-1.99881	0.045630	-2.01242	0.044177	13	11	0.040954
Naps day shift (H)			0.0000	0.00000	1.000000	0.00000	1.000000	5	1	0.000000
naps day off			0.0000	0.00000	1.000000	0.00000	1.000000	6	1	0.000000
How many hours sleep needed	181.0000	197.0000	76.0000	-0.70363	0.481664	-0.73188	0.464244	14	13	0.487948
Amount of sleep achieved in the day	194.5000	183.5000	74.5000	-0.73193	0.464215	-0.83139	0.405751	15	12	0.455864

amount of sleep between days off	116.0000	137.0000	50.0000	-0.65665	0.511406	-0.69171	0.489117	11	11	0.519032
Sleep quality in the day	210.0000	196.0000	74.0000	-0.99811	0.318226	-1.07620	0.281840	16	12	0.323780
Sleep quality between days off	105.5000	147.5000	50.5000	-0.59344	0.552886	-0.63516	0.525325	10	12	0.538659
How rested you feel in the day	204.5000	201.5000	68.5000	-1.25344	0.210045	-1.32540	0.185038	16	12	0.205310
how rested days off	103.0000	150.0000	48.0000	-0.75829	0.448279	-0.81824	0.413223	10	12	0.456151
wake up earlier than intended in the day	226.5000	179.5000	90.5000	-0.23212	0.816446	-0.25028	0.802372	16	12	0.801706
wake earlier than intended days off	103.5000	149.5000	48.5000	-0.72532	0.468257	-0.78138	0.434581	10	12	0.456151
Difficulty falling asleep in the day	216.0000	190.0000	80.0000	-0.71957	0.471791	-0.74032	0.459104	16	12	0.478020
difficulty falling asleep days off	94.5000	158.5000	39.5000	-1.31876	0.187250	-1.36419	0.172507	10	12	0.180194
Feel tired on day shifts	206.0000	200.0000	70.0000	-1.18381	0.236490	-1.24343	0.213711	16	12	0.240820
Feel tired on days off	123.0000	153.0000	57.0000	-0.52314	0.600878	-0.54957	0.582615	11	12	0.607524
Total SDS	214.0000	221.0000	78.00000	-1.11825	0.263462	-1.11880	0.263226	16	13	0.268039
Sleep Disturbance Day shift	203.0000	203.0000	67.0000	-1.32308	0.185810	-1.32854	0.183999	16	12	0.189005
Sleep Disturbance Days off	116.0000	184.0000	38.0000	-1.93412	0.053099	-1.94174	0.052170	12	12	0.051865
Sleeping pills day	188.0000	190.0000	68.0000	-1.04909	0.294136	-1.54832	0.121545	15	12	0.299543
sleeping pills day off	107.5000	145.5000	52.5000	-0.46157	0.644393	-0.68589	0.492781	10	12	0.627738
alcohol to sleep day	209.0000	169.0000	89.0000	-0.02440	0.980536	-0.05371	0.957167	15	12	0.980869
alcohol days off	122.5000	130.5000	52.5000	0.46157	0.644393	0.77388	0.439003	10	12	0.627738
General energy reverse	180.0000	198.0000	75.0000	-0.75216	0.451958	-0.78916	0.430021	14	13	0.458269
drained	172.0000	179.0000	67.0000	-0.84867	0.396066	-0.88994	0.373499	14	12	0.402547
active reverse	207.5000	198.5000	71.5000	-1.11417	0.265206	-1.15931	0.246331	16	12	0.260053
tired most of	158.0000	167.0000	67.0000	-0.57112	0.567916	-0.59113	0.554434	13	12	0.574293
Vigor reverse	121.5000	178.5000	43.5000	-1.61658	0.105970	-1.70899	0.087454	12	12	0.100530
lethargic	136.0000	164.0000	58.0000	-0.77942	0.435731	-0.87740	0.380269	12	12	0.442833
alert reverse	158.5000	166.5000	53.5000	-1.25913	0.207983	-1.30782	0.190934	14	11	0.202177
exhausted	173.5000	177.5000	68.5000	-0.77152	0.440401	-0.80317	0.421878	14	12	0.431892
lively reverse	153.0000	198.0000	48.0000	-1.82592	0.067863	-1.89907	0.057556	14	12	0.067266
weary	165.0000	186.0000	60.0000	-1.20871	0.226775	-1.30585	0.191603	14	12	0.231155
Chronic Fatigue Score	94.0000	137.0000	39.0000	-1.09148	0.275064	-1.11301	0.265707	10	11	0.281620

A comparison of variables for permanent night and rotating nurses working night shifts only.

variable	Mann-Whitney U Test (w/ continuity correction) By variable Night x Rotating Marked tests are significant at p <.05000									
	Rank Sum Group 1	Rank Sum Group 2	U	Z	p-value	Z adjusted	p-value	Valid N Group 1	Valid N Group 2	2*1sided exact p
General energy reverse	209.5000	255.5000	102.5000	0.31389	0.753606	0.33404	0.738349	13	17	0.741562
drained	196.0000	300.0000	110.0000	0.14194	0.887125	0.15174	0.879389	12	19	0.888881
Night shift start	150.0000	228.0000	84.0000	-0.17271	0.862878	-0.22613	0.821098	11	16	0.865261
Night shift end	148.5000	229.5000	82.5000	-0.24673	0.805116	-0.36451	0.715479	11	16	0.789694
Travel time to night shift (MIN)	195.5000	210.5000	57.5000	1.66993	0.094934	1.68499	0.091992	11	17	0.090623
Travel time from night shift (MIN)	192.5000	213.5000	60.5000	1.52881	0.126312	1.53534	0.124702	11	17	0.121916
Do you feel unsafe travelling to/from night	173.0000	262.0000	91.0000	0.33710	0.736042	0.36675	0.713803	11	18	0.740218
No. successive night shifts	80.0000	220.0000	52.0000	-0.44458	0.656627	-0.62601	0.531310	7	17	0.664003
Total no successive shifts before day off	71.0000	160.0000	16.0000	-2.71109	0.006707	-2.79685	0.005161	10	11	0.004786
Max no shifts before days off in the past month	79.0000	57.0000	24.0000	-0.59656	0.550802	-0.60370	0.546041	10	6	0.562188
Average no of successive days off	145.0000	320.0000	67.0000	-1.71450	0.086438	-1.77011	0.076709	12	18	0.086537
Night shifts followed by	36.0000	117.0000	21.0000	-0.89598	0.370265	-0.96599	0.334048	5	12	0.382676
average nights worked p/year	24.0000	129.0000	14.0000	-1.30212	0.192877	-1.31425	0.188762	4	13	0.201681
Physical workload night	172.0000	263.0000	94.0000	-0.33211	0.739810	-0.38590	0.699573	12	17	0.743777
Mental workload night	166.5000	239.5000	86.5000	0.30576	0.759786	0.33116	0.740523	11	17	0.746115
Time pressure night	168.0000	238.0000	85.0000	0.37632	0.706677	0.39635	0.691844	11	17	0.711318
Emotional stress night	188.5000	189.5000	69.5000	0.97590	0.329115	1.02339	0.306123	12	15	0.322857
Choose start time night	139.5000	211.5000	75.5000	0.21082	0.833029	0.22391	0.822829	10	16	0.815935
Choose end time night	190.5000	187.5000	51.5000	1.77647	0.075656	1.89172	0.058530	11	16	0.071229
Fall asleep before night shift	179.5000	198.5000	45.5000	1.95818	0.050210	1.98908	0.046693	10	17	0.045937
Wake up after night shift	210.5000	167.5000	14.5000	3.51468	0.000440	3.56174	0.000368	10	17	0.000117
Sleep duration Night	103.0000	150.0000	45.0000	0.71665	0.473591	0.72032	0.471329	8	14	0.482172
Fall asleep on days off	187.5000	277.5000	106.5000	0.04233	0.966233	0.04302	0.965683	12	18	0.950179
wake up on days off	218.0000	310.0000	120.0000	0.11511	0.908359	0.11592	0.907717	13	19	0.909717

Sleep duration Days off	189.5000	245.5000	74.5000	1.07872	0.280713	1.08624	0.277375	11	18	0.275828
naps night shift			0.0000	0.00000	1.000000	0.00000	1.000000	1	7	0.000000
naps day off			0.0000	0.00000	1.000000	0.00000	1.000000	1	8	0.000000
How many hours sleep needed	222.0000	274.0000	103.0000	0.54043	0.588899	0.56999	0.568688	13	18	0.594059
amount of sleep between suc nights	137.5000	187.5000	67.5000	0.38829	0.697802	0.43123	0.666302	10	15	0.682951
amount of sleep between days off	154.0000	122.0000	44.0000	1.32323	0.185759	1.39237	0.163812	11	12	0.189587
Sleep quality between suc night	159.5000	165.5000	45.5000	1.60863	0.107698	1.72616	0.084320	10	15	0.102507
Sleep quality between days off	205.5000	145.5000	40.5000	2.21168	0.026989	2.31749	0.020478	12	14	0.023364
how rested night	154.5000	170.5000	50.5000	1.33128	0.183098	1.39291	0.163647	10	15	0.177495
how rested days off	197.0000	154.0000	49.0000	1.77449	0.075983	1.83342	0.066742	12	14	0.075691
wake earlier than intended night	156.0000	195.0000	75.0000	0.36330	0.716381	0.40233	0.687441	11	15	0.721104
wake earlier than intended days off	181.0000	170.0000	65.0000	0.95154	0.341332	1.03028	0.302881	12	14	0.347446
difficulty falling asleep night	191.5000	186.5000	50.5000	1.82582	0.067879	1.92438	0.054307	11	16	0.063513
difficulty falling asleep days off	164.0000	187.0000	82.0000	0.07715	0.938503	0.08007	0.936186	12	14	0.939590
Feel tired on night	176.0000	202.0000	66.0000	1.06095	0.288715	1.20513	0.228154	11	16	0.294213
Feel tired on days off	173.5000	177.5000	72.5000	0.56578	0.571544	0.59285	0.553284	12	14	0.560450
Total SDS	275.5000	285.5000	75.50000	1.989566	0.046640	1.990564	0.046530	13	20	0.043489
Sleep Disturbance Night shift	186.0000	192.0000	56.0000	1.55441	0.120087	1.57325	0.115661	11	16	0.121431
Sleep Disturbance Days off	222.5000	183.5000	47.5000	2.22834	0.025858	2.23478	0.025433	12	16	0.022556
sleeping pills night	167.0000	239.0000	89.0000	-0.30175	0.762839	-0.36643	0.714046	12	16	0.766584
sleeping pills day off	152.5000	172.5000	74.5000	-0.16318	0.870378	-0.20641	0.836474	12	13	0.851719
alcohol to sleep night	176.0000	230.0000	94.0000	0.06964	0.944484	0.15601	0.876026	12	16	0.945412
alcohol days off	150.0000	175.0000	72.0000	-0.29916	0.764818	-0.53012	0.596028	12	13	0.768887
General energy reverse	209.5000	255.5000	102.5000	0.31389	0.753606	0.33404	0.738349	13	17	0.741562
drained	196.0000	300.0000	110.0000	0.14194	0.887125	0.15174	0.879389	12	19	0.888881
active reverse	231.5000	233.5000	62.5000	1.90500	0.056781	2.08706	0.036884	12	18	0.053097
tired most of	203.0000	232.0000	79.0000	0.99632	0.319097	1.02768	0.304103	12	17	0.324532
Vigor reverse	199.5000	206.5000	70.5000	1.16060	0.245807	1.35772	0.174554	12	16	0.240820
lethargic	186.0000	249.0000	96.0000	0.24354	0.807584	0.26474	0.791213	12	17	0.810617
alert reverse	188.0000	218.0000	65.0000	1.31713	0.187796	1.36344	0.172745	11	17	0.191163

exhausted	176.0000	259.0000	98.0000	-0.15498	0.876835	-0.16586	0.868268	12	17	0.878822
lively reverse	227.0000	208.0000	55.0000	2.05905	0.039490	2.24839	0.024552	12	17	0.038041
weary	192.0000	214.0000	78.0000	0.81242	0.416553	0.85540	0.392330	12	16	0.422750
Chronic Fatigue Score	178.0000	200.0000	64.0000	1.15964	0.246196	1.17095	0.241618	11	16	0.250976