AN EVALUATION OF FATIGUE MANAGEMENT STRATEGIES UTILIZED BY ADVANCED LIFE SUPPORT PROVIDERS IN KWAZULU-NATAL

A dissertation submitted in fulfilment of the requirements for the Degree of Master of Health Sciences in Emergency Medical Care in the Faculty of Health Sciences at the Durban University of Technology

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DECLARATION OF ORIGINALITY

This is to certify that the work is entirely my own and not of any other person, unless explicitly acknowledged (including citation of published and unpublished sources). The work has not previously been submitted in any form to the Durban University of Technology or to any other institution for assessment or for any other purpose.

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ETHICAL CLEARANCE

This is to certify that this study has ethical approval by the Institutional Research Ethics Committee (IREC) of DUT.

The allocated ethics clearance number is: IREC 208/21 (Appendix A)

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ABSTRACT

Introduction

Personnel employed by emergency medical services in the pre-hospital environment are required to work shifts in order to ensure that help is available at any time of the day, due to the unpredictable nature of emergency situations. Shift work results in elevated levels of fatigue that are often unavoidable. Emergency medical care providers, in particular advanced life support providers, utilise informal fatigue management strategies to safeguard themselves and their patients from the harmful effects and symptoms associated with fatigue from shift work. Fatigue is a danger to the health, safety, and performance, of advanced life support providers and their patients. Currently, the use of informal fatigue management strategies within the emergency medical care services is unclear and requires additional study.

Aim of the study

This research determined the use of informal fatigue management strategies by local advanced life support providers.

Methodology

A quantitative cross-sectional study was undertaken, utilising a survey questionnaire that was used to collect relevant data on the advanced life support provider's perceived personal experiences related to fatigue, and their utilisation of informal fatigue management strategies. In addition, associations between variables were tested using cross-tabulations. Fisher's exact two-sided tests and Spearman's rho were used to validate the associations between the participants' perception of fatigue and fatigue management strategies.

A total of n=66/86 participants who met the inclusion criteria completed the survey (76.7% completion rate). After reading the information letter, or viewing and starting the survey, n=20/86 (23.3%) potential participants dropped out as they did not meet the inclusion criteria. A large number of advanced life support providers did not meet the inclusion criteria due to their non- operational status.

Results

Participants reported their experiences of a total of 12 effects, signs, and symptoms associated with fatigue, which were primarily divided into health, safety, and performance categories. The evaluation of their fatigue management strategies consisted of 24 questions. Following this, they were then asked seven questions exploring their personal sentiments about fatigue management.

The results demonstrated that the majority of the participants understood the concept of fatigue and were generally confident in their fatigue management strategies. This enabled them to reduce the risks associated with fatigue. However, nearly half the participants n=32/66 (48.5%) expressed health-related problems as a consequence of fatigue. These health-related signs and symptoms experienced by the participants may be an area of concern. Moreover, this prevented them from keeping to their regular lifestyle habits, which consisted of rest and recovery; with dietary and social implications.

Of the participants, n=49/66 (74.2%) felt that fatigue management strategies improved their clinical management and safety. The participant's length of shift duration included either 12 hour, 24 hour, or up to 48 hour standby shifts. The participants' length of shift did not appear to impact on their making clinical management errors. Noting, n=55/66 (83.3%) participants indicated they had not made clinical management errors in the last month, while n=42/65 (64.6%) participants reported that their personal or their patients' safety was 'occasionally' compromised by way of fatigue. Regarding performance, n=20/66 (30.3%) participants felt their fatigue management strategies worked when used on an 'always' basis. Added to this, sixteen of sixty-six participants felt their fatigue management strategies reduced their signs and symptoms associated with fatigue when used on an 'always' basis. Oddly, there was no link found between being able to identify the symptoms of fatigue and subsequently making use of energy drinks (caffeine) or a light snack to relieve the effects of fatigue.

Conclusion

When considering the data from this study, based on the advanced life support providers personal experiences, they had pro-actively developed informal fatigue management strategies as a defence mechanism. This allowed them to safeguard against the health, safety, and performance shortfalls of operating in a fatigued state that is beyond the point of

safe practice. It is recommended that continued education be made available to the employers and advanced life support providers on the benefits of fatigue management. Individual providers should ensure that they optimise their rest and recovery periods. Putting into routine practice various fatigue management strategies may ensure a safe and affective essential emergency medical care service to their communities.

Key words

Fatigue; shift-work; fatigue-proofing; fatigue-mitigation; emergency medical services; strategies and methods; validated fatigue assessment**.**

DEDICATION

To my parents, thank you for encouraging ‘lifelong learning’. This thesis is dedicated to my family: my wife, Sapphire, you are the good in selfless service unto others, thank you for being my motivation; and my son Aleksander, may you find joy and meaning in ‘lifelong learning’. To the emergency medical care service personnel who work tirelessly behind the scenes and are always a call away, those that would not hesitate to put themselves on the front line to serve our community. A more noble and thankless calling cannot be imagined.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

List of Appendices

DEFINITION OF KEY TERMS

Advanced life support: Level of care consisting of capabilities and responsibilities of Paramedics, Emergency Care Technicians and Emergency Care Practitioners who practise emergency medical care, as determined by the Health Professions Council of South Africa in terms of the Health Professions Act, 1974 (Act No. 56 of 1974) (Department of Health South Africa, 2021).

Advanced life support provider: This group of providers comprise three registration categories on the Board of Emergency Care within the Health Professions Council of South Africa. These registration categories include Paramedics (A.N.T.), Emergency Care Technician (E.C.T.), and Emergency Care Practitioner (E.C.P.). An advanced life support provider renders a level of emergency care within their capabilities and responsibilities in the prehospital domain, as determined by the Health Professions Council of South Africa in terms of the Health Professions Act, 1974 (Act No. 56 of 1974) (Department of Health South Africa, 2021). They practise to a level of care that consists of invasive lifesaving procedures including, but not limited to, advanced airway management; mechanical ventilation; intravenous access and fluid administration; emergency cardiovascular care; administration of various medications according to predetermined protocols; electrocardiogram interpretation and management of life-threatening dysrhythmias; manual defibrillation; and transcutaneous pacing (Department of Health, 2014, 2021; DoE, 2014; Health Professions Council of South Africa, 2018).

Basic Life Support provider: This provider is registered in the Basic Ambulance Assistant category. The Basic Ambulance Assistant list of capabilities as determined by the Health Professions Council of South Africa in terms of the Health Professions Act (56 of 1974) (Department of Health, Govt. Gazette, 2014) includes the use of non-invasive emergency procedures as required. These procedures include cardiopulmonary resuscitation; control of bleeding and the stabilisation of fractures; and the immobilisation of possible spinal injuries (Stedman, 2006; Health Professions Council of South Africa, 2018). A basic life support provider also refers to the level of emergency care provided by Basic Ambulance Assistants.

Clinical supervision: Supervision is described as a professional activity performed by competent individuals. It involves observation, feedback, mutual problem solving, and collaborative interaction with self-reflection (Falender & Shafranske, 2004). The advanced life support providers are professional, independent, and competent individuals; they provide clinical supervision to their colleagues, as part of their duties and responsibilities to provide a safe environment for the provider and patient. Locally, advanced life support providers implement and manage systems which support the provision of quality healthcare and prevent patient safety incidents (Department of Health South Africa, 2021).

Emergency Care Assistant: This is an emergency medical care provider registered in the Emergency Care Assistants category. This provider has obtained a National Higher Certificate in Emergency Medical Care. This registration category allows providers a variety of non-invasive and invasive emergency procedures prehospitally which include intravenous therapy, defibrillation, and medication administration. It refers to a level of emergency care provided and practised, as determined by the Health Professions Council of South Africa in terms of the Health Professions Act (56 of 1974) (Health Professions Council of South Africa, 2016b)

Emergency Care Practitioner: This is an advanced life support registration category and providers on this register hold a Bachelor's Degree in Emergency Medical Care. An Emergency Care Practitioner is able to render an advanced level of care according to the prescribed list of capabilities within the context of the prehospital environment as determined by the Health Professions Council of South Africa in terms of the Health Professions Act, 1974 (Act No. 56 of 1974) (Department of Health South Africa, 2021).

Emergency Care Technician: This is an advanced life support registration category and providers in this category hold a National Certificate in Emergency Care who renders a level of emergency care in the prehospital area within the capabilities and responsibilities as determined by the Health Professions Council of South Africa in terms of the Health Professions Act, 1974 (Act No. 56 of 1974) (Department of Health South Africa, 2021).

Emergency medical care: This refers to the evaluation, treatment and care of an ill or injured person in a situation in which such emergency evaluation, treatment and care are required;

and the continuation of treatment and care during the transportation of such person to, or between, health establishments (Health Professions Council of South Africa, 2018b).

Emergency medical care provider: This includes all personnel who are registered with the Health Professions Council of South Africa under the auspices of the Professional Board for Emergency Care. This also includes Paramedics, Emergency Care Technicians and Emergency Care Practitioners (advanced life support providers), who practise their skill with a list of capabilities, as determined by the Health Professions Council of South Africa in terms of the Health Professions Act, 1974 (Act No. 56 of 1974). Emergency medical care providers render emergency prehospital and humanitarian care to the ill and injured and provide safe transport to a medical facility for the continuation of care that the patient requires (World Health Organization, 2008; Department of Basic Education, 2014; Department of Health South Africa, 2021).

Emergency medical services: This is a system of organisations or services co-ordinated and dedicated to providing support and medical assistance which ranges from primary response to definitive care, involving personnel trained in the rescue, stabilisation, transportation and advanced treatment of traumatic or medical emergencies. The emergency medical service is a multi-faceted response system which is usually activated by a member of public by phoning an emergency number. Once activated, resources such as ambulance personnel, rescue equipment and first responders will be dispatched to the scene of the emergency (Stedman, 2006; Department of Health South Africa, 2021).

Fatigue: Fatigue is considered to be an unpleasant state, comprising psychological and physiological effects and symptoms that may range from mild tiredness to complete exhaustion, and manifesting acutely and chronically (Patterson *et al.*, 2012). Fatigue may also be defined as experiencing tiredness or a dislike of one's current situation or activity; or an unwillingness, difficulty, or lack of motivation to continue to perform at optimal level, with a progressive decline in awareness of the environment. Moreover, fatigue is a gradual and cumulative process that reflects in a decline in health, safety, and performance. As a consequence, there is reduced competence and willingness to maintain goal-directed behaviour aimed at adequate health, safety, and performance (de Vries, Michielsen and van Heck, 2003).

Health Professions Council of South Africa (HPCSA): The Health Professions Council of South Africa is a statutory body, established in terms of the Health Professions Act No. 56 of 1974 and is committed to protecting the public and guiding the professionals (Health Professions Council of South Africa, 2007). The Health Professions Council of South Africa is the regulatory body governing all prehospital care in South Africa (*Legal and Regulatory Affairs - HPCSA*). The HPCSA consists of 12 Professional Boards. One of which is the Professional Board for Emergency Care. This Board has nine registration categories in which pre-hospital health care providers are mandated to register in order to practice (Health Professions Council of South Africa, 2016b).

Intermediate Life Support provider: This is an emergency medical care provider registered in the Ambulance Emergency Assistant category. This registration category allows for a variety of non-invasive and invasive emergency procedures in the prehospital area which include intravenous therapy, defibrillation and drug administration (Stedman, 2006; Health Professions Council of South Africa, 2018). It refers to a level of emergency care provided and practised, as determined by the Health Professions Council of South Africa in terms of the Health Professions Act (56 of 1974) (Department of Health, Govt. Gazette, 2014).

Medical emergency: These are conditions requiring rapid intervention to avert death or disability; and those for which treatment delays of hours, or less, make interventions less effective (Department of Health South Africa, 2021).

Paramedic: A Paramedic is an advanced life support provider registered in the Paramedics register category, this provider holds either a National Diploma in Emergency Medical Care, National Diploma in Ambulance and Emergency Care Technology or a Critical Care Assistant certificate who renders a level of emergency care in the prehospital environment within the capabilities and responsibilities as determined by the Health Professions Council of South Africa in terms of the Health Professions Act, 1974 (Act No. 56 of 1974) (Department of Health South Africa, 2021).

Paramedic Practice: This role refers to the ‘’Professional Stream’’ of Australian paramedics, their roles and capabilities are defined by jurisdiction and level of qualification. Qualified

individuals will register as Paramedic (Paramedic), Intensive Care Paramedic (ICP), Retrieval Paramedic (RP), or General Care Paramedic (GCP). These paramedics are registered with the Paramedicine Board of Australia, managed by the Australian Health Practitioners Regulation Authority (AHPRA) (Paramedics Australasia, 2012).

Patient safety/harm to life: This refers to reducing the risk of unnecessary harm associated with healthcare to an acceptable minimum (Stedman, 2006).

Patients' rights charter: This ensures the realisation of the right of access to healthcare services, as guaranteed in the Constitution of the Republic of South Africa, 1996 (Act No. 109 of 1996), and is a common standard for achieving the realisation of this right to access healthcare (Health Professions Council of South Africa, 2007).

Philosophy of 'Ubuntu': The phrase 'Ubuntu' can be translated as 'a person is a person because of, or through, others'. 'Ubuntu' can further be described as the capacity, in an African culture, to express compassion, reciprocity, dignity, humanity and mutuality in the interests of building and maintaining communities with justice and mutual caring. (University of Pretoria, 2006)

Pre-hospital: This is any environment outside the emergency department/casualty resuscitation room, or place allocated for resuscitation in a healthcare setting (Stedman, 2006).

Shift work: Shift work may be regarded as a work pattern that is required by specialised industries and services, such as emergency medical services; nursing; safety and security services; and fire-rescue services; along with other industries. Historically, shift work extends beyond the regular Monday-to-Friday eight-to-five working routine (Ramey *et al.*, 2019).

World Health Organisation (WHO): The World Health Organisation came into existence on 7 April 1948 and has the goal of building a better, healthier future for all people all over the world. With offices in more than 150 countries, World Health Organisation staff work side-by-side with governments and other partners to ensure the highest attainable level of health for all people (Stedman, 2006; World Health Organization, 2008).

CHAPTER ONE: OVERVIEW OF THE STUDY.

1.1 Introduction

This chapter commences by presenting the background to this study, which includes the local relevance of this work. The chapter then presents the problem statement, research questions, aim, and the objectives proposed to achieve the aims. The chapter ends by briefly introducing the research methodology utilized, as well as providing a brief overview of the chapters that follow.

1.2 Background

1.2.1 Emergency medical care and the advanced life support provider

The World Health Organization (2008) recognises and advocates that every person has the right to access healthcare and medical treatment, and as such this is a basic human right. In South Africa this basic constitutional right, and the philosophy of 'Ubuntu', articulate the fundamental underpinning for the provision of healthcare services and emergency medical care to the patient at all times, day and night, and in all areas (University of Pretoria, 2006).

Emergency medical services, or pre-hospital emergency medical care, are still relatively new disciplines within the broader medical field. Consequently, emergency medical care and rescue advances are still being developed and refined internationally, and locally within South Africa (Vincent-Lambert, 2015). Pre-hospital emergency medical care is the provision of emergency medical care or rescue to ill and injured persons at the scene of an emergency, with subsequent transportation to hospital for the definitive care that they require (Health Professions Council of South Africa, 2018).

In South Africa, this pre-hospital emergency medical care is provided by emergency medical care providers at various defined levels of care. These defined levels of emergency medical care include basic, intermediate, and advanced life support, all providing different levels of capabilities to treat the patient at the scene of an emergency. Basic and intermediate life support providers are often assigned to work together on an ambulance, whilst an advanced

life support provider is usually assigned to work alone or with a partner on a rapid response vehicle. In some instances, an advanced life support provider may be teamed with a partner on an ambulance specifically for the purpose of critical care retrieval cases (Department of Health South Africa, 2021).

Advanced life support providers perform operational duties within a dynamic, high-stress environment, and have a far greater responsibility in shift management and capabilities of practice when compared with their Basic and Intermediate Life Support-qualified colleagues (Cash *et al.*, 2020). Advanced life support providers ensure the care and transport of the ill and injured to definitive care while providing advanced emergency interventions on board an emergency vehicle (Republic of South Africa, 2003; Ramey *et al.*, 2019). The advanced life support providers provide a level of clinical care to patients and require a higher degree of cognitive function in this high-stress and often hazardous dynamic environment. South African advanced life support providers are required to provide 24-hour coverage of emergency medical care to the community through a shift-working structure. Given the complexities of the advanced life support providers' role and their susceptibility to the effects of shift work, this makes this population and their informal fatigue management strategies central to this study.

1.2.2 Shift work and related stressors, a fatigue inducing environment

Shift work may be regarded as a work pattern that is required by specialised industries and services, such as the emergency medical service; nursing; safety and security services; and fire-rescue services; along with other industries. Historically, shift work extends beyond the regular Monday-to-Friday, eight-to-five, working routine (Ramey *et al.*, 2019). Emergency medical care providers work shifts, often without the opportunity for quality rest periods, and with the added complexities and stressors associated with fulfilling the role of an advanced life support provider. Locally, a limited number of advanced life support providers deliver care to an extremely large population, in contrast to international ratios. In a survey conducted by Govender *et al.* (2012), insight into the working environment South African advanced life support providers encounter on a daily basis was gained (Govender *et al.*, 2012). Moreover, the authors described the target ratios of advanced life support providers to population, compared to actual ratios of advanced life support providers to population, within the KwaZulu-Natal province. The target ratios in KwaZulu-Natal were one advanced life support provider to a population of 15,929 residents. However, the actual ratio of advanced life

support providers available to the local population was 1:270,749 (Govender *et al.*, 2012). This limited number of advanced life support providers available per geographical area and population has the potential to result in prolonged response times to the scene, as well as decreased patient access to emergency medical care (MacFarlane, Van Loggerenberg and Kloeck, 2005). Given these conditions, where an advanced life support provider is responsible for covering this densely populated geographical area, they may be busier with consecutive emergencies, which further increases the likelihood of fatigue, with less frequent rest periods (Patterson, Weaver, *et al.*, 2018). Additionally, shift work requires the provision of a 24-hour service, incorporating both a day shift and a night shift (Reinecke, 2017). As a result of shift work, advanced life support providers are subjected to circadian rhythm disruption and are thus at an increased risk of the effects and symptoms associated with fatigue (Barger *et al.*, 2018).

1.2.3 Fatigue and shift work

The very nature of emergency medical care services necessitates 24-hour shift work in order to provide the life-saving service required in emergencies. This can only be achieved with shift work that is often lengthy and unpredictable (Patterson. P, *et al*. 2016). Consequently, emergency medical care providers, in particular advanced life support providers, are exposed to the risks of fatigue which may threaten their health, performance, and their safety, as well as that of their patients. Fatigue is experienced by emergency medical care providers the world over (Courtney, Francis and Paxton, 2010). However, South African advanced life support providers experience challenging and difficult shift working conditions, which together create a stressful and fatigue-inducing environment. Fatigue is seen as an unpleasant state, comprising psychological and physiological effects and symptoms that may range from mild tiredness to complete exhaustion (Patterson *et al.*, 2012).

Emergency medical care providers get less quality sleep, reducing the likelihood of effective recovery. In a national study conducted in the United States, Cash *et al.* (2020) noted that, on average, 60-70% of adults enjoyed seven-or-more hours of sleep per night, compared with half that percentage for emergency care providers on average; with resultant high sleep-debt (Cash *et al.*, 2020). The compounding effect is an inability to adequately recover from fatigue. Furthermore, the researchers found that shift-working emergency medical care providers are more likely to experience poor sleep, compared to other shift-working industries and services

within the United States. Similarly, studies by Patterson *et al*., (2015) found that 50% of emergency medical care providers reported that they experienced disproportionate daytime sleepiness and fatigue and felt unrested on the commencement of their shift cycle (Patterson *et al*., 2015).

Internationally, Myers *et al.* (2018), Patterson *et al*. (2015), and Pirrallo et al. (2012) have confirmed that fatigue is experienced amongst shift-working emergency medical care providers, and this fatigue is linked to decreased safety, poor performance, and several chronic medical conditions (Pirrallo *et al.*, 2012; Patterson *et al*., 2015; Myers *et al.*, 2018). Considering the above, shift work-induced fatigue is undoubtedly a threat to the safe and effective provision of emergency medical care, for both the provider and the patients they are responsible for. This leaves the advanced life support provider vulnerable to its effects and symptoms if it is left unmanaged. It is evident that emergency medical care providers experience shift work-related fatigue and suffer the consequences of poor inter-shift recovery.

1.2.4 Fatigue management

As the emergency medical care service continues to provide a service to its local communities, strategies must be sourced, identified, and refined, to protect, adapt to, or proof against, the effects of fatigue. This will assist in producing a robust and healthy emergency medical care advanced life support provider, capable of safely delivering lifesaving treatment to the community.

Fatigue is known to be the underlying cause of psychological, physiological, and safety concerns around the world in multiple shift-working disciplines, industries, and services, including the emergency medical care service. Fatigue is a subjective experience and is experienced personally by many who work shifts. Fatigue research within the emergency medical care service has been documented (Bérastégui *et al.*, 2018). However, documented studies on the management of fatigue are limited in the emergency medical care services and, in particular; it remains unexplored in the South African context. Indeed, within the local emergency medical care services, the advanced life support providers are not spared this psychological and physiological strain.

Fatigue-related protective behaviours in pre-hospital emergency medical care are often practised informally by emergency medical care providers. Two such methods used in protective fatigue management are fatigue proofing and fatigue mitigation (Bérastégui *et al.*, 2018). Barger *et al.* (2018) have highlighted that fatigue proofing is a form of sleep/recovery education, and fatigue mitigation is the strategic use of techniques to reduce the risks of fatigue (Barger *et al.*, 2018). Moves towards fatigue proofing and fatigue mitigation have been successfully implemented abroad and are producing positive outcomes within the emergency medical care services internationally (Patterson *et al*., 2015; Patterson *et al.*, 2017; Patterson, Higgins *et al.*, 2018; Temple *et al.*, 2018).

In South Africa the pre-hospital emergency medical care services appear to be delayed in implementing fatigue-proofing and fatigue-mitigating strategies, as these strategies have not been identified and formalized as of yet. As the effects of fatigue are known, these informal behaviours require further study to improve the performance, health, and safety of the providers and the communities they serve.

1.2.5 The local context

South African advanced life support providers may face the consequences of fatigue due to shift work on a daily basis. The levels and frequency of their fatigue as a result of shift work are unknown; and the strategies to manage fatigue are unclear. However, it is hypothesised that South African advanced life support providers, like to their international colleagues, do indeed practise informal fatigue management strategies; and these strategies must be evaluated and formalised. Still, limited information exists within the local emergency medical care service context in relation to fatigue-proofing and fatigue-mitigating trends. Therefore, a locally based study is important.

1.3 Problem Statement

The effects and symptoms associated with fatigue on occupational performance and safety, as well as on the health of shift-working emergency medical care providers, have been documented internationally by Patterson, Higgins *et al.* (2018) and Ramey *et al.* (2019). There is a paucity of local evidence on the effects and symptoms associated with fatigue on advanced life support providers' health, clinical performance, and subsequent safety. It,

therefore, remains a challenge to safely manage fatigue in local advanced life support providers. The current use of fatigue proofing and mitigation systems in South Africa is unknown. It is theorised, local advanced life support providers have intuitively developed their own informal fatigue management strategies that reduce the risks and allow them to continue to operate in a fatigued state. These strategies must be developed and disseminated to safely manage fatigue; and techniques must be defined to expand on current informal practices in order to improve on the performance, safety, and health of advanced life support providers in the South African context.

1.4 Research Questions

In light of the context of the research, as described above, the research questions developed are as follows:

1. What is the frequency and severity of identifiable effects and symptoms associated with fatigue, as reported by shift workers who are local advanced life support providers?
2. What fatigue management strategies do these providers use to adapt to, and limit, shift-work fatigue; and are these informal strategies successful?

1.5 Aim of the Study

In order to address the research questions, the central aim of the research was to determine the use of informal fatigue management strategies by local advanced life support providers in order to safeguard themselves from operating in a fatigued state that is beyond the point of safe practice.

1.6 Objectives of the Study

In order to achieve the above stated aim, the objectives of this study were as follows:

1. Identify and analyse the frequency and severity of effects and symptoms associated with fatigue related to performance, safety, and health, as experienced by local shift-working advanced life support providers.
2. Evaluate the efficacy of informal fatigue-mitigating and fatigue-proofing strategies that are utilized by local shift-working advanced life support providers.

1.7 Delimitation of the Field and Scope of the Study

The delimitation of the field of study refers to the characteristics which limit the scope and define boundaries. Delimiting factors include the researcher's selection of objectives, the research question, and the population selected for evaluation (Maree, 2007). As this research was conducted in the South African province of KwaZulu-Natal, only local data was sought. Individuals from private emergency medical care services and provincial emergency medical care services who work shifts in this region were invited to participate.
The limitations in this study included the cross-sectional design. Convenience sampling may also be a limitation, due to either a (possible) sampling error or a lack of representation. Snowball sampling was used in conjunction with convenience sampling as an additional strategy to maximise participation.

Online surveys may produce low response rates, or potential respondents may not be interested in participating; and for this reason, the study may not be generalised to the overall population (Maree, 2007). An additional limitation to this study is the use of the self-reporting method of gathering data from the respondents. This is an imperfect system, but it is used frequently. Central to this study is the respondents' perceived experience of fatigue and the extent to which their informal fatigue management efforts are effective. Therefore, participants may have felt disinclined to participate, as acknowledging fatigue could have negative connotations in terms of job performance and the status of the individual.

For the purpose of this study, only advanced life support providers were chosen to participate. This population is at greater risk of developing and working in a fatigued state that may be a threat to safe practice.

1.8 Research Design and Methods

The most suitable study design to optimise the objectives, with a focus on the study aim, and to answer the research questions, was descriptive and quantitative in nature. This design presents data in such a way to best describe current local fatigue management strategies. When quantitative research is conducted it yields numerical data from specific sub groups, which allows for data interpretation and comparison (Maree, 2007).

Considering this design, data gathering methods included sourcing information from relevant literature, along with a survey tool which was used to collect numerical data that provided locally relevant evidence. Evaluations of current fatigue management practices, and not trends, were conducted. This described the data from the participants, and its characteristics, at a single point in time. Building on the above, this allowed testing of the researcher's hypothesis relating to the participants' experiences and use of fatigue management strategies.

Further discussion related to the research design, sampling methods and data collection, including ethical considerations, will be addressed in Chapter 3.

1.9 The Researcher's Interest in the Field

The researcher has served in the fire-rescue and emergency medical care service previously, both internationally and locally, and is currently employed in the emergency medical care service in the role of an operational advanced life support provider as an Emergency Care Practitioner. Fatigue is a topical issue and has played a role in the researcher's shift working career and, as such, the researcher has not been spared its effects. Consequently, the researcher has a relationship with fatigue and has attempted to gain insight into fatigue management by incorporating various informal strategies, resulting in limited successful and unsuccessful techniques that have either proofed against, or mitigated, its risks.

This process has sparked an interest in the researcher, who has identified that, locally, there has been limited research. There are still areas needing improvement; and the concept of managing fatigue needs to be developed further. The effects and symptoms associated with fatigue have consequences for shift workers, and over time the researcher has noticed his colleagues being at odds with the effects of fatigue. Consequently, there is a sincere concern for their safety, health and performance. For this reason, the researcher is committed in his search to determine the effective management of fatigue in order to allow for safer shift work for both the providers and their patients.

1.10 Significance and Value of the Study

Once completed, this study may provide locally relevant pre-hospital emergency medical care data, which can be used in further studies; as well as contributing to the existing body of evidence. Information will be made available to facilitate improved awareness, nationally, amongst emergency medical care services about the effects and symptoms associated with fatigue and how to manage this efficiently and safely. Making recommendations available to the emergency medical care community allows advanced life support providers to be empowered and confident in their decision to operate in a safer manner and not to risk performance, safety, and their health, whilst reducing the negative connotations of acknowledging fatigue. This will result in a more robust and healthy emergency medical care advanced life support provider, capable of safely delivering lifesaving treatment and rescue to their communities.

1.11 Outline of the Thesis and Chapters to Follow

This section provides a brief outline of the layout of the thesis:

Chapter One: Overview of the Study.

This chapter introduced the purpose, aim and background to the study. Furthermore, the nature of shift work fatigue and its impact on advanced life support providers has been introduced.

Chapter Two: Literature Review

This chapter will bring together and review the current body of knowledge pertaining to fatigue and its management and shortfalls.

Chapter Three: Research Methodology

In this chapter the study design, as well as the methodology and instrument utilized to obtain the data and the results, will be discussed.

Chapter Four: Results

This chapter will present the results from the data collected, in keeping with the objectives of the study.

Chapter Five: Discussion

This chapter will present and discuss the findings drawn from the analyses of the yielded data. Findings will also be corroborated by current local and international literature.

Chapter Six: Conclusion and Recommendations

This chapter will conclude the study and summarise the results and discussion in order to make appropriate recommendations drawn from the study.

1.12 Summary

Advanced life support providers work shifts within the emergency medical care service, and as such experience fatigue; consequently, they are exposed to the effects and symptoms associated with fatigue. Fatigue effects both cognitive and physical functioning, and has implications for both clinical management and safety, with concerns for both the advanced life support provider and the patient being treated. Internationally, fatigue proofing and mitigation strategies have shown positive outcomes by limiting the effects and symptoms associated with fatigue. Locally, safe and effective strategies for fatigue proofing and fatigue mitigation have not as yet been formalised, and current informal strategies have not been clearly defined; nor have they been evaluated within the emergency medical care profession. The use of these strategies for fatigue proofing, fatigue mitigation and fatigue management amongst South African advanced life support providers remains unknown. As such, research is warranted into the use of fatigue management strategies, as utilized among local advanced life support providers. In the next chapter, a literature review of the existing literature will provide the context to fatigue and fatigue management within the emergency medical care service.

CHAPTER TWO: LITERATURE REVIEW.

2.1 Introduction

This chapter brings together and reviews the current body of knowledge pertaining to emergency medical care service providers, their unique job requirements, and their shift-working structure required by the inherent nature of emergency medical care. This chapter provides the background, from the current literature, related to fatigue experienced by shift working emergency medical care providers and highlights the use of fatigue management strategies. Essentially, this chapter will further refine the ideas that are central to this study.

2.2 Search Strategy

In order to find existing literature on the effects associated with fatigue on advanced life support providers, and their implementation of fatigue proofing and fatigue mitigation, a literature review was conducted. A structured stepwise search was undertaken, which allowed for a greater search domain given the paucity of literature on the subject. The content search and evaluation started with the key words as a minimum set of requirements for reporting on the subject matter. The researcher's strategy involved finding publications, journals, reports, books, statutes, web sites, case reviews, and theses (university repositories), which included the relevant key words with similar design and methodologies. The following key words were used to identify publications for study: fatigue; shift-work; fatigue-proofing; fatigue-mitigation; emergency medical services; strategies and methods; validated fatigue assessment. Boolean terms connecting the search criteria included 'and', 'or', 'in'. Materials were sourced and reviewed from the PubMed; ResearchGate; Cochrane Reviews; Science Direct; Medline; and Google Scholar websites, with a search spanning fifteen years, including seminal work. Content that was related to emergency medical services, other health care providers, and similar high risk shift working industries was sought from the above mentioned resources. Considering this literature, the researcher then screened the abstracts of journals systematic reviews, meta-analysis, case reporting, websites, tables of contents from statutes, and key word searches in order to establish links to the problem statement that would best relate to this research.

Inclusion criteria and final assessments required that the full article be available if possible and determined the relevant information and characteristics be linked to emergency medical care providers, other healthcare providers, and high risk industry shift workers. Building on this, additional requirements included: shift work related fatigue; the effects and symptoms associated with fatigue; methods of fatigue-proofing and mitigation amongst healthcare providers.

Limited studies, which included emergency medical care and other health care providers, could be directly linked to the proposed research area; literature related to high risk industry shift workers was added to increase the search domain. Studies that did not directly relate to, or include, the specified fields of interest were discarded. In particular a great number of studies pertained to fatigue, but were generalised to other industries and services with only some relevance to shift-working emergency medical care providers, other healthcare providers, and high risk industry shift workers.

2.3 A General Overview of Emergency Medical Services

Emergency medical care, or pre-hospital care, is the provision of emergency medical care or rescue at the scene of the event, and the transportation of ill and injured patients to definitive care. Emergency services including paramedic practice has been described as high risk, as it incorporates elements from other high-risk industries and services such as aviation, transport, and medicine (Ramey *et al.*, 2019). In South Africa, the emergency medical care service spans the same industries and services and is provided by emergency medical care providers at various defined levels of care (MacFarlane, Van Loggerenberg and Kloeck, 2005). One such level is the advanced life support level of care. Advanced life support providers are required to work shifts in the emergency medical care service in the pre-hospital health care sector in order to respond to emergencies at any time. They are required to respond to emergencies of any nature, in any environment, day or night; which are often unpredictable (Stein, Wallis and Adetunji, 2015).

An emergency is defined by the World Health Organization (2008) by the following criteria: when a person’s health is placed in serious jeopardy; or when impairment of bodily functions, or serious dysfunction of any bodily organ or system, is identified (World Health Organization,

2008). The advanced life support provider is required to provide the necessary emergency medical care, or rescue, at the scene of the event to manage the emergency and to limit harm to life. Emergencies may be comprised of trauma, which is a direct mechanical insult to the body, or a medical emergency that may be an illness with acute emergency implications. The patient is provided with up-to-date, best-practice medical care by the advanced life support provider and is transported safely to the nearest appropriate facility for the continuation of their medical care. Alternatively, the advanced life support provider may be required to provide the same level of care, as received in hospital, to patients who are transported from one medical facility to another for further medical management (Przepiorka, 2002; Department of Health, 2014; Department of Health South Africa, 2021).

Much of the literature that was reviewed has been of research conducted in small, localised studies, or within single emergency medical service sectors or divisions, or small niche groups, using convenience sampling, with few conducted as randomised control trials. Some research used focus groups; other research applied survey instruments. One such study conducted in Australia produced data from a limited convenience sample of ambulance emergency medical care providers (n=60) (Sofianopoulos *et al.*, 2011). This study was similar in sample size and the assessment tools that were used although seminal were relevant in keeping with the aims of the study. Most of the literature that was reviewed consisted primarily of systematic reviews and meta-analyses of the available literature. These designs, potentially, cover a large body of literature and give a summary of the current evidence on the subject of fatigue; they also minimise bias. Moreover these designs have a transparent approach, spanning the current body of knowledge. One study conducted on sleep/rest and stress in basic-versus-advanced life support emergency medical care providers, used a significantly larger sample group that consisted of the national United States register of emergency medical care technicians who were required to re-certify for service, which provided a greater volume of data (Cash *et al.*, 2020). Noting the above study sample, it was relevant as it included advanced life support providers and occasionally drew comparison to their basic life support colleagues. What is more, there is limited literature related to advanced life support providers only, literature trends were focused on emergency medical service providers as a whole and did not differentiate between the various levels of patient care or provider capability. Considering the limitations to these studies, the researcher obtained

information from literature exploring other high-risk shift working industries with similarities to the emergency medical services.

Taking into account the requirements of emergency medical care services to provide the emergency medical care needed by the community, regardless of the location and type of emergency, the advanced level of care provided by local advanced life support providers delivers a level of care that is both complex and physically demanding.

2.4 The Advanced Life Support Provider in the South African Context

Emergency medical care services in South Africa are governed by the Health Professions Council of South Africa which constitutes twelve professional boards, one of which is the Professional Board for Emergency Care (Health Professions Council of South Africa, 2016b). The Professional Board for Emergency Care currently comprises nine registration categories. Pre-hospital health care providers are required to register in a category according to their qualification. Their registration category will determine their list of capabilities with which they practice either in an independent or a supervised capacity (Health Professions Council of South Africa, 2016b).

The Professional Board for Emergency Care regulates different register categories. The entry level of care is the Basic Ambulance Assistant (B.A.A.) registration category. At this level, the provider is capable of delivering basic lifesaving interventions such as basic cardiopulmonary resuscitation and basic manual airway manoeuvres and wound care. The basic ambulance assistant, or basic life support provider can administer limited medications within their defined list of capabilities (Republic of South Africa, 2009). Another registration category is the Ambulance Emergency Assistant (A.E.A.) register. The Ambulance Emergency Assistant or intermediate life support provider is capable of providing more invasive therapies, including intravenous therapy, needle thoracentesis, and manual cardiac defibrillation. Additional medications are added to the Ambulance Emergency Assistants defined list of capabilities. The Emergency Care Assistant (E.C.A.) is another category of registration. Capabilities for this provider consist of invasive therapies including intravenous therapy, needle thoracentesis, emergency medications, and manual cardiac defibrillation. Within these categories of

registration, practice is supervised. (Health Professions Council of South Africa, 2018a; Macfarlane, 2004; Health Professions Council of South Africa, 2018).

Additional registration categories include; Paramedics (A.N.T.) register, Emergency Care Technicians (E.C.T.) register, and the Emergency Care Practitioners (E.C.P.) register. These registers comprise the advanced life support providers. Each qualification has a respective category of registration and each has their defined list of capabilities for independent practice (Health Professions Council of South Africa, 2016b). Within their specific capabilities of practice, which cover most medical and trauma-related emergencies out of hospital, the advanced life support provider has a far larger defined list of capabilities including (but not limited to) the basic life support and intermediate life support capabilities. Added to this, invasive or definitive airway techniques; lifesaving cardiac treatment modalities; diagnostic interpretations; and a broader array of medications to dispense (Department of Basic Education, 2014; Stein *et al.*, 2016; Health Professions Council of South Africa, 2018a, 2018c). Advanced life support providers have a set of ethical principles and clinical guidelines that form part of their foundation of professional practice as clinicians (Health Professions Council of South Africa, 2018a). As clinicians, they are expected to apply and formulate clinical decision making based on sound current medical evidence that initiates the continuum of a gold standard of care for the patient. Added to this clinical aspect and complex cognitive loading, the advanced life support provider has shift management duties resulting in increased work-load responsibilities (Health Professions Council of South Africa, 2018c).

The autonomous capabilities, increased stress, complex cognitive load, and leadership/management roles that impact on the advanced life support provider are of importance to this study. These factors compound drastically, increasing the likelihood of developing shift work-related fatigue. The focus of this research will be exclusively on this shift-working population who practise their profession independently.

2.5 Shift Work Requirements of Advanced Life Support Providers

Emergency medical care providers are required to work in a rotational shift structure in order to provide a 24/7 emergency medical care service to the community. Historically, shift work

extends beyond the regular Monday-to-Friday, eight-to-five, working routine (Ramey *et al.*, 2019). Furthermore, shift work requires covering duties during both the day time and the night time (Reinecke, 2017). As a result of this, emergency medical care providers are subjected to circadian rhythm disruption (Barger *et al.*, 2018). Shift work may encompass 12-hour shifts, 24-hour shifts, and even 72-hour shifts; with off-duty periods between these, on duty shift periods, including standby shifts, which are a continual form of shift work (Reinecke, 2017). Shift work in the emergency medical care service often comprises long periods of stagnation, followed by periods of high mental and physical intensity, stress and engagement. In order to provide a continual service to their communities, emergency medical care providers' shifts may vary in duration and intensity, and for this reason they are susceptible to the effects of shift work. Thus, shift work can have a detrimental effect on emergency medical care providers (Sofianopoulos *et al.*, 2011).

As a consequence of the rotational structure of emergency medical care services' shift pattern requirements, researchers have identified that emergency medical care providers do not adequately recover between their on-duty shift periods (Daniel Patterson *et al*., 2015; Ramey *et al.*, 2019). Consequently, these emergency medical care providers inadvertently start their next shift in an amplified state of exhaustion. In addition, an unstructured non-systematic review of current literature on fatigue suggested that this is due to differences between actual deep sleep, providing recovery, and other sleep opportunities which do not (Ramey *et al.*, 2019).

Emergency medical care and other healthcare providers have experienced health, safety, and performance concerns as a result of shift work. Surgical trainees participated in a survey which identified shift work-related driving habits. The researchers aimed to assess the impact of fatigue on driving safety. The researchers made use of an electronic survey to capture data on sleepiness and motor vehicle accidents. Of the respondents, 97% reported that fatigue compromised their safety whilst driving to or from work. The researchers concluded that shift work-related fatigue impaired safe driving (Freedman-Weiss *et al.*, 2021). Furthermore, another study related to shift work attributed emergency vehicle crashes to operator workload and fatigue resulting from long driving hours and irregular shifts. The same authors recognized that emergency driving is a great deal more demanding than non-emergency driving, and have identified 'time pressure' as one of the most hazardous task-related

characteristics. This refers to the urgent need to arrive at the scene of an event within a limited time, in order to provide optimal emergency medical care to the patient. This has resulted in more crashes occurring during the emergency phase, driving to the scene of an emergency (Hsiao, Chang & Simeonov, 2018). While this study focused on multiple agencies comprising the emergency services (police, fire-rescue, and ambulance) and not specifically emergency medical services, it provided insight into the challenges faced by these providers. In addition, the United States Air Force conducted a pilot study on the impact of shift work on air crew safety. The authors concluded that shift work-related impairment was linked to major crashes. Moreover, building on the above, shift duration, sleep opportunities, and some tasks and environmental influences that may exacerbate the effects of fatigue have been identified as causative factors (Morris *et al.*, 2020).

Consequently, a common trend has been demonstrated – namely that fatigue has been experienced among shift-working emergency medical care providers and other healthcare providers, and this fatigue is linked to decreased safety, poor performance, and several chronic medical conditions (Pirrallo *et al.*, 2012; Daniel Patterson *et al*., 2015; Myers *et al.*, 2018). Internationally, the rotational patterns of shift work and the rest/recovery periods in between have been shown to be inadequate. This inadequate rest/recovery period has led to fatigue-induced chronic medical conditions and reduced performance, with job safety implications. South African emergency medical care providers are required to work shifts that are comparable to international requirements and they are, thus, inclined to experience similar effects and symptoms associated with shift work fatigue. Considering the aforementioned, the emergency medical care service is an example of a working environment in which the development of fatigue and fatigue-related risks are often unavoidable, due to the inherent nature of its requirement to provide a service 24/7 (Dawson *et al.*, 2017).

2.6 Advanced Life Support Providers and Shift Work within the South African Context

In many ways, South Africa mirrors international systems. However, there are some differences specific to the South African context that impact on the emergency medical care providers and this makes a locally-based study relevant. Locally, access to healthcare and access to the ill or injured patient may be challenging. Several advanced life support providers work in remote and rural areas where they are required to travel vast distances to the scene

of an emergency (Stein *et al.*, 2016). Local advanced life support providers deliver care to an extremely large population over a large geographical area, in contrast to international ratios. As a result of this, the community's emergency medical care requirements are not adequately met (Govender *et al.*, 2012).

Shift work often includes difficult working conditions. These conditions include difficult patient access and confirming an appropriate medical facility, based on the patient's needs. Furthermore, resources may be limited for the advanced life support provider and this may impact on clinical decision-making capabilities related to the continuum of patient care (Govender *et al.*, 2012). Having fewer advanced life support providers available per geographical area may increase response times, and decrease patient access, to emergency medical care (Patterson, Higgins, *et al.*, 2018; Statistics South Africa, 2018).

Advanced life support providers are often dispatched while on shift to unsafe, unstable, and violent scenes. Added to this, risks include adverse weather conditions; day or night time; poor lighting; road collision carnage; chemical spillage; bodily fluids; dangerous individuals; and other careless road users (Macfarlane, 2004). These emergency scenes may be stressful, emotionally charged, and dangerous. Police services are required on these scenes for the safety of the emergency medical care providers and the patients they care for. These factors increase the likelihood of indirect trauma and the development of stress-related fatigue (Renkiewicz & Hubble, 2021). Moreover, local advanced life support providers practise with a greater degree of autonomy than their international counterparts as they practice independently assuming higher levels of responsibility and decision making toward their patients' clinical management and safety (Department of Health South Africa, 2021). This level of clinical independence is specifically noted within the clinical practice of an Emergency Care Practitioner as they are not required to consult with a supervising medical officer when treating patients. Local advanced life support providers are often faced with higher emergency call-out volumes in comparison to their international counterparts (Govender *et al.*, 2012). Also, labour law and industry requirements pertaining to the number of working hours differ from country to country, including South Africa (van Huyssteen, 2016).

Noting the aforementioned, it is evident that local advanced life support providers often face hazardous, unpredictable, and emotionally challenging circumstances while on shift. These

compounding factors are added to the duties and responsibilities of the advanced life support provider. These factors increase the likelihood of developing fatigue. While fatigue management has been researched internationally, the levels of fatigue and the informal fatigue management strategies utilised in a local context remain unclear.

2.7 Implications of the Duties and Responsibilities Associated with Shift Work

In South Africa, shift work allows for the provision of emergency medical care to the ill and injured at all times of day and night, and in all areas. Advanced life support providers are assigned either with a partner, or individually, to a rapid response vehicle; or they may be teamed with a partner on an ambulance to provide this life-saving service. They perform their operational duties within a dynamic, high-stress environment, and have far greater responsibility in shift management and in their defined capabilities related to emergency medical care practice, compared with their Basic and Intermediate Life Support colleagues (Cash *et al.*, 2020). Their defined list of capabilities is broad and encompasses management modalities for all medical and trauma emergencies encountered in the pre-hospital arena, and is centred on the stabilization and safe transportation of the ill and injured to definitive hospital care (Daniel Patterson *et al.*, 2018).

The advanced life support provider has added responsibilities and duties to complete while on shift. These duties and responsibilities include administrative tasks, which comprise clinical and performance quality governance and supervision within their area of operations. Advanced life support providers are also expected to lead their shift, ensuring ambulance, equipment and staff availability; safely responding to emergencies at high speed; and taking command of emergency scenes, including autonomous clinical patient management and time-sensitive decision making. Moreover, advanced life support providers have a physical component to their duties, namely lifting and carrying patients and equipment as well as traversing uneven terrain (Ramey *et al.*, 2019). Overall, advanced life support providers ensure the care and transport of the ill and injured to definitive care while providing advanced emergency medical care interventions on board an ambulance (Ramey *et al.*, 2019: Government Gazette, 2017).

Emergency medical care service shift work is unpredictable and challenging. South African advanced life support providers are required to provide 24-hour coverage of emergency medical care to the community through a shift-working structure. These duties, responsibilities, and strenuous physiological and psychological activities, as mentioned above, place the advanced life support provider in a vulnerable position and susceptible to the development of fatigue (Ramey *et al.*, 2019). Moreover, the implications of shift work and the demands inherently placed on advanced life support providers during the course of their duties, often prevent them from recovering. This compounds and amplifies the effects and symptoms associated with shift work and contributes to the further development of fatigue (Patterson, Weaver, *et al.*, 2018).

2.8 Implications of Fatigue on Advanced Life Support Providers

There are a number of definitions for the meaning and the causes of fatigue. Of relevance for this study, fatigue has been highlighted as a complex medical occurrence in emergency medical care providers, including the advanced life support provider (Daniel Patterson *et al*., 2015). It can be further defined as a sensation of tiredness or sleepiness; often it is as a result of compounding emotional, physiological, and environmental factors (Ramey *et al.*, 2019). Researchers have linked the effects associated with fatigue in other shift-working industries and services to the emergency medical care service and therefore relevant data can be extrapolated for use (Patterson *et al.*, 2012; Dawson *et al.*, 2017). Emergency medical care providers with all levels of qualification experience fatigue, and the associated symptoms, in all aspects of their operational duties. As advanced life support providers work shifts, they are susceptible to the risks and effects of fatigue, which have also been seen in other shift-working groups (Patterson *et al.*, 2018). The effects and symptoms experienced locally are consistent with those experienced internationally, by shift workers within emergency medical care services. The definitions and identification of fatigue are comparable in international and local emergency medical care providers. Furthermore the association of fatigue with the shift working environment, as described by international researchers, is comparable to the local shift-working environment.

The effects and symptoms induced by shift-work fatigue, as experienced by advanced life support providers, include safety, performance and health issues, which are central concerns.

Moreover, these effects were further refined to include insufficient rest, road traffic incidents and patient safety concerns (Patterson *et al.*, 2012). Patterson *et al*. (2018) confirmed that the psychological and physiological effects of fatigue are experienced by a great many providers within the emergency medical care service and have impacted their safety, performance, and health. Data from a study of air ambulance emergency medical care service providers showed that providers had developed sleep deficits, amplifying their fatigue (Patterson *et al.*, 2017). Moreover, a systematic review alluded to the risks faced by emergency medical care providers as a result of shift-work fatigue, which included ambulance road traffic incidents, patient treatment errors, and chronic health problems (Temple *et al.*, 2018). Local advanced life support providers face the same risks because of shift work-induced fatigue; and the objective of this study was to expose the frequency of the effects and symptoms experienced.

Ramey *et al.* (2019) suggested that factors causing fatigue included aspects such as length of shift, shift structure and rest/recovery time between shifts. Furthermore, health status, sleep/recovery quality, diet, and stress levels, play a pivotal role in the development of fatigue, resulting in safety, performance, and health complications for the employer, emergency medical care provider, and the patient. As has been stated, it is often difficult to measure the effects of fatigue, as it is a subjective concept and experience for each individual (Ramey *et al.*, 2019). Patterson *et al*. (2017) confirmed this in their study, trialling fatigue management strategies among emergency medical care providers at an air ambulance medical service. The participants provided live data over a period of time, specifically quality of sleep and self-reported fatigue and sleepiness over long shifts. Although this was a single-centre study with limited participants, whose shifts were consistently 12 hours, the researchers concluded that many experienced differing levels of self-reported consequences of fatigue. Moreover, serious sleep debt was recorded and, indeed, accepted as a precursor to chronic fatigue and poor recovery (Patterson *et al.*, 2017). The development and causes of fatigue have been considered above. However, the effect of fatigue is difficult to gauge among individuals as their perceived experience often differs.

Limited methods exist to identify and report on stress, burnout, and fatigue. Studies have drawn similarities between these conditions. Boschman and Dresen (2017) assessed specific job requirements based on these fundamentals, but focused on fatigue and its implications within the emergency medical care services in the Netherlands (Boschman & Dresen, 2017).

Overall, the physical, mental, and emotional ability to cope with the job requirements of the emergency medical care service, along with other similar shift-working industries and services, were analysed and associations were made using a worker health surveillance tool. The worker health surveillance tool adequately measured physicality and questioned emotional and mental well-being for the emergency service and other high-risk industry fatigue. The researchers made use of a cross-sectional design. The survey tool, in combination with the cross-sectional design, determined similar adverse implications, effects, and symptoms associated with fatigue found in other emergency medical care providers. When taking the Boschman and Dresen (2017) study into account, given their similar shift working job requirements for physicality, emotional and mental well-being, it was likely that local advanced life support providers experienced similar effects and symptoms associated with fatigue.

Patterson *et al.* (2012) highlighted certain effects and symptoms associated with fatigue and identified poor safety outcomes and poor sleeping, due to fatigue, by utilising a survey combined with a Likert-type scale questionnaire (Patterson *et al.*, 2012). The study used convenience sampling and a cross-sectional design. The proportion of participants who reported injuries (n=91, 17.8%) was higher amongst the advanced life support provider group. The likelihood of injury among participants reporting poor sleep was 2.3 times higher than those reporting good sleep. The likelihood of injury among the participants reporting fatigue was 2.9 times higher than those reporting as non-fatigued. Four out of every ten participants reported making medical errors within the last three months (n=210, 41.1%). A large proportion (n=458, 89.6%) of respondents reported a perceived safety risk to themselves and their patients; while more than half of the participants reported severe fatigue while at work (n=281, 55%). Moreover, a higher percentage (n=309, 59.5%) of these respondents were advanced life support providers with greater levels of responsibility (Patterson *et al.*, 2012). Patterson *et al.* (2015) also conducted a cross-sectional survey on inter-shift recovery within the emergency medical care service, and later Patterson *et al.* (2017) conducted a randomised control trial and found that more than half of the participants reported that they could not recover effectively from fatigue their shifts (Patterson *et al*., 2015; Patterson *et al.*, 2017). The cross-sectional design utilised by Patterson *et al.* (2012; 2015) proved valuable as it demonstrated the current situation at a specific point in time. In addition, the randomised

control trial allowed for transferability to the general population of emergency medical care providers (Patterson *et al.*, 2012; Patterson *et al*., 2015).

Considering the above implications, advanced life support providers experience fatigue as a result of shift work, with subsequent and related fatigue-induced safety concerns; health problems; performance repercussions; and poor recovery rates, during shift work. South African advanced life support providers work in similar shift patterns and with similar job requirements. It may thus be concluded that they may experience similar fatigue-induced effects.

2.9 Effects and Symptoms Associated with Fatigue

A survey on fatigue among nursing staff, who also work both day and night shifts, with responsibilities including administrative duties and patient care, demonstrated significant fatigue-related outcomes. Outcomes of concern were identified as the effects and symptoms associated with fatigue, a deficit in recovery, and circadian rhythm disruption. Added to this, an association was exposed between fatigue, insufficient sleep and stress, which resulted in clinical management errors, presenting as difficulties in recalling patient diagnostic parameters; performing procedures; medication administration problems; and patient recording (Kagamiyama & Yano, 2018). Although this was a small single centre study, this study's outcome has local relevance as, like the nursing staff, who are shift-working healthcare providers, advanced life support providers also have patient and administrative duties, with an added physical component. Based on this, the advanced life support providers also experience similar deficits as a consequence of shift work and circadian rhythm disruption induced by fatigue.

Risks, as well as the signs and symptoms associated with fatigue, include, but are not limited to: chronic tiredness; headaches; vision disturbances and hallucinations; delayed reflex and motor function; slowed or impaired decision-making capability; agitation and moodiness; short-term memory problems and poor concentration; general malaise, and body temperature dysregulation (Bérastégui *et al.*, 2018; Cash *et al.*, 2020). Risks to health occur predominantly if there are underlying health issues such as high blood pressure, diabetes, obesity, and heart problems. Furthermore, risks within the workplace include injuries as a result of fatigue

(Ramey *et al.*, 2019). In addition, symptoms that have been associated with fatigue include sleepiness; visual disturbances; a lack of focus; a lack of empathy; and increased appetite (Bérastégui *et al.*, 2018). Health implications resulting from fatigue were highlighted by Patterson *et al.* (2012) and Ramey *et al.* (2019) who indicated that hypertension, obesity, diabetes, and increased injuries on duty were associated with fatigue (Patterson *et al.*, 2012; Ramey *et al.*, 2019). These risks and symptoms may affect the day-to-day capability and general well-being of the advanced life support provider.

The risk profile, effects and symptoms associated with fatigue have consistently been found across the literature that was reviewed. Shift-work fatigue has been recorded across other high-risk industries and services and has been found to be consistent with what has been documented within the emergency medical care service (Patterson, Higgins *et al.*, 2018). Based on the literature reviewed above, advanced life support providers experience the consequences of shift-work fatigue. The dire consequences of fatigue substantiate the need for research into fatigue management within the emergency medical care service in order to limit the short-term and long-term risks and effects.

2.10 Fatigue Management

While there has been research into fatigue within specialized industries and services, including the emergency medical care service, fatigue management strategies have been studied to a lesser degree and are still a relatively new concept. The importance of performance, health and safety are the main reasons for fatigue management strategies. It has been noted that a growing body of evidence suggests an inverse association between performance and safety as a result of fatigue (Donnelly *et al.*, 2019).

Relating to emergency medical care service shift-work fatigue, a 2018 publication entitled '*Evidence-based guidelines for fatigue risk management in Emergency Medical Services',* by Patterson *et al*., was put forward for review by authorities and a panel of experts in the field for further validation. This publication included systematic literature reviews that were conducted for a 36-year period, and paid close attention to shift-worker fatigue, and in particular, emergency medical care service shift-worker fatigue. This data was analysed for evidence to establish fatigue management guidelines specific to emergency medical care

services. These guidelines could be tailored to establish formalised fatigue management strategies. From the analysed data, evidence existed for validated safety and fatigue risk management protocols within other high-risk industries and services. However, these safety and fatigue risk management protocols lacked validity within the emergency medical care service. Other fatigue management recommendations were found to have little supporting evidence. Nonetheless, supporting literature exists which suggests their potentially successful transfer to, and implementation within the emergency medical care service, limiting the harmful effects of fatigue. Overall this study revealed outcomes that can be transferred to the emergency medical care service and utilized in the context of formal shift-work fatigue management (Patterson *et al.*, 2018).

Similar high-risk industries and services utilise established local labour regulations or occupational health and safety protocols. For example, management of shift work hours in an attempt to avoid fatigue, and regulated rest periods. These fatigue management systems are recognised evidence-based guidelines and processes. However these strategies may not apply directly to the unique environment and unpredictability of the emergency medical care service. Within the emergency medical care service, advanced life support providers work shifts with no scheduled rest time, and are susceptible to the effects associated with fatigue. Nonetheless, limited fatigue training, recognition, and management exist. However, the emergency medical care service lacks direction on how to formally mitigate and proof against shift work-related fatigue (Patterson *et al.*, 2018). It is theorised that, locally, advanced life support providers experience the same lack of direction and formal fatigue management, and experience constant sleep deficits as a consequence of minimal recovery time from working in a fatigued state. Accordingly, there is consensus that emergency medical care services need fatigue management systems in place; and therefore it remains a challenge to safely manage fatigue in local advanced life support providers.

Considering the paucity of formal fatigue management strategies mandated within the emergency medical care services, a study implemented in Pittsburgh, in the United States of America, has shown relevance in the emergency medical care service, internationally and locally, as it placed previously informal fatigue management strategies into a formal format (Patterson *et al.*, 2018). Patterson,Weaver *et al.* (2018) and Barger *et al.* (2018) conducted their research from the Pittsburgh School of Medicine and have developed fatigue

management guidelines specific to the emergency medical care service, with the overall aim of reducing the likelihood of experiencing the effects of fatigue. Guidelines were only put in place in the emergency medical care service in the city of Pittsburgh (Barger *et al.*, 2018; Patterson, Weaver *et al.*, 2018). Based on this, the fatigue management guidelines were formalised and implemented by the National Association of State Emergency Medical Service Officials (Washington & Falls, 2018). The trial is relevant to this locally-based study as it implemented formal fatigue management guidelines and strategies within the emergency medical care service. The measures listed below are central to fatigue management strategies, as have been self-reported by respondents previously. The strategies that were implemented consisted of five recommendations approved by the expert panel and authorities in the service (Patterson *et al.*, 2018).

The strategies and guidelines for fatigue risk management were:
1) Use fatigue/sleepiness surveys to measure and monitor fatigue among emergency medical care providers.
2) Limit shifts to less than 24 hours in duration.
3) Provide on-duty shift-working providers with access to caffeine to limit fatigue.
4) Allow providers the opportunity to nap while on duty.
5) Provide education and training in fatigue risk management to emergency medical care service providers.

These guidelines reflect the consensus in fatigue management strategies found across the literature and have been practised informally by shift-working emergency medical care providers and other shift-working personnel. The recommended guidelines will enable the emergency medical care providers to resist fatigue and to maintain safe levels of practice.

It is required that the essentials of a tailored and formalised fatigue management system within the emergency medical care service should incorporate a reduction in the effects and symptoms associated with fatigue, to result in an improvement in performance, health, patient and provider safety, and clinical efficacy. Moreover, it is important to identify and formalise the informal fatigue management strategies utilised within local emergency medical care services. Currently the implications of emergency medical care service shift work and evidence on managing fatigue is limited. Boschman and Dresen (2017) and Ramey *et al.* (2019) reviewed

studies related to fatigue management, using systematic review tools, and established that shift workers within high risk industries and services, including the emergency medical care service, experience shift work-related fatigue and the negative implications thereof (Boschman & Dresen, 2017; Ramey *et al.*, 2019). Considering the international literature related to informal and formal fatigue management strategies and guidelines, further study, refinement, and adaption is required in both an international and local context.

Consensus in fatigue management has been documented consistently and two fundamental complimentary approaches have been identified: fatigue proofing and fatigue mitigation (Barger *et al.*, 2018; Bérastégui *et al.*, 2018; Patterson *et al.*, 2018; Ramey *et al.*, 2019). Bérastégui *et al.* (2018) indicated that fatigue proofing and fatigue mitigation strategies have been primarily practised informally and complement the reduction of fatigue (Bérastégui *et al.*, 2018). Using these contemporary approaches, locally-based research into informal fatigue mitigation and fatigue proofing strategies will benefit the advanced life support providers through a reduction in fatigue-related risks and affects.

2.11 Fatigue Proofing

Fatigue proofing strategies aim to reduce the likelihood that an individual will make an error during work-related activities. Fatigue proofing educates against the risks of fatigue. It includes techniques to reduce sleepiness by incorporating sufficient rest, diet, and exercise. Additionally, fundamental components of fatigue education and training for shift workers should include basic information on sleep and circadian rhythms, sleep disorders, and the use of fatigue-proofing strategies (Barger *et al.*, 2018).

Barger *et al*. (2018) conducted a systematic review and meta-analysis of fatigue proofing, education systems, and fatigue mitigation techniques, for pre-hospital shift workers (Barger *et al.*, 2018). This research demonstrated that fatigue training improved personal and patient safety outcomes and reduced stress and burnout. Added to this, the study also confirmed an improvement in sleep quality for emergency medical care shift workers. The researcher concluded by recommending that further studies be undertaken to optimise fatigue training programmes.

To gain insight into informal fatigue-proofing strategies, a recent study by Bérastégui *et al.* (2018) utilised a focus group consisting of emergency physicians. It was identified that the emergency physicians adopted various informal techniques to proof themselves against fatigue, which had positive outcomes on their self-reported fatigue-associated symptoms (Bérastégui *et al.*, 2018). Similarly, Dawson *et al*. (2017; 2021) made use of semi structured interviews to gather data on defence aviation personnel and emergency services personnel who make use of informal fatigue-proofing techniques (Dawson *et al.*, 2017; Dawson, Ferguson & Vincent, 2021). Their self-reported symptoms of fatigue were well-established and are relevant to this study as they reflect the self-reported effects and symptoms personally experienced by the participants in this study. The fatigue-proofing strategies that they practised informally were successful for the participants and show relevance to the South African context as local advanced life support providers practise similar, informal fatigue-proofing strategies (Dawson *et al.*, 2017).

The above authors used unstructured interviews and focus groups in their research. The advantage of these methods is that the participants feel comfortable, thus allowing free conversation. Focus groups may discourage the participants from divulging information that may portray them in a negative light in the company of their colleagues, However a topic that affects the entire group may lead to open discussion as memories or experiences are activated by other participants' inputs (Maree, 2007). In the above examples of fatigue proofing, the participants were not employed in the emergency medical care service. However, these participants were professional individuals, aviation specialists and medical physicians, and they worked shifts in high-risk industries and services. This gives validity to the study and their perceived experiences and informal fatigue proofing strategies. Accordingly these informal techniques can be applied in the emergency medical care service.

Across similar high-risk industries and services, shift workers employ informal fatigue-proofing strategies, although they are not part of a formal, structured protocol within their specific workplaces. Fatigue proofing-strategies have been evaluated, but not all may have the appropriate desired effects, especially when weighted against risk/benefit outcomes (Patterson *et al.*, 2018). Fatigue-proofing education and training has been found to have positive results and is readily available on multiple platforms and using many delivery methods; but South African emergency medical care shift workers remain unaware of its

existence. It has been determined, through a meta-analysis data review, that there is a favourable relationship between education and training and certain fatigue-proofing strategies (Barger *et al.*, 2018).

The literature provided similar themes regarding fatigue proofing and has determined that shift workers who experience fatigue make use of informal fatigue-proofing strategies. Some strategies may have detrimental outcomes if utilised within the emergency medical care service, but further training and education is required to avoid this (Patterson *et al.*, 2018). Conversely, both Barger *et al.* (2018) and Patterson *et al.* (2018) found that when fatigue-proofing strategies were implemented in an effort to manage provider and patient safety and improve on clinical management; the outcomes were favourable and consistent (Barger *et al.*, 2018; Patterson *et al.*, 2018). It is important to educate and familiarize advanced life support providers on the benefits of fatigue-proofing strategies. The informal strategies that were practised demonstrated the ability to reduce the effects and symptoms associated with fatigue.

During the course of their shifts, advanced life support providers may meet strenuous physical, cognitive, and emotional challenges. Although the benefits of regular exercise and a healthy diet are well known, advanced life support providers are often unable to maintain healthy lifestyle habits (MacQuarrie *et al.*, 2018). Fatigue-proofing strategies may alleviate the burden of these challenges and reduce the likelihood of developing fatigue and chronic health complications. MacQuarrie *et al.* (2018) identified multiple barriers to regular exercise and a healthy diet, which resulted in increased risks of acute and chronic fatigue, ultimately leading to chronic health, safety, and performance problems (MacQuarrie *et al.*, 2018). The authors suggested that, in the long term, shift work-related fatigue, lack of fitness, and the high rates of injury incurred during shift periods may contribute to poorer health outcomes in the advanced life support providers. As a result, their general well-being and quality of life was lower than that of non-emergency medical care service personnel. The authors generated their data from the New South Wales ambulance service, Australia, and made use of a web-based survey instrument. Corresponding barriers to regular exercise and healthy diets exist for local South African advanced life support providers. Barriers to overcome include limited prospects for education; time and financial constraints; family responsibilities; and distance to, and opportunity for, exercise.

Taking the above into account, it is recommended that training and education form an important aspect of fatigue proofing. Training and education strategies, such as getting adequate rest in a favourable environment prior to shift work; avoiding heavy meals prior to the commencement of shift work; regular exercise and healthy lifestyle habits, are paramount in obtaining a level of fatigue proofing and reducing the likelihood of developing fatigue. Moreover fatigue-related accidents should be recorded and regarded as a learning opportunity (Morris *et al.*, 2020). The education and training concept was further reinforced in a systematic review by Barger *et al*. (2018). Data which was captured highlighted participants' attendance at fatigue education sessions, and the attendees subsequently reported fewer injuries and errors at work (Barger *et al.*, 2018). When conducting local research into informal fatigue- proofing strategies utilised by advanced life support providers, comparisons can be made with internationally documented strategies. Recommendations can be made on these findings regarding supplemental education and training, if required. This study will add to the existing body of evidence about fatigue proofing.

2.12 Fatigue Mitigation

Fatigue-mitigation strategies ensure that an individual, who is experiencing symptoms associated with fatigue, has limited exposure to workplace responsibilities and duties. Fatigue-mitigating measures include napping; increased caffeine intake; environmental manipulation; and shift length re-alignment, amongst other strategies. Many of these have been selectively and cautiously incorporated into the emergency medical service, internationally (Bérastégui *et al.*, 2018; Patterson, Higgins *et al.*, 2018; Washington & Falls, 2018).

Strategic napping may improve alertness and reduce the effects of shift work-induced fatigue. Ruggiero and Redeker (2014) reported, in a systematic review of the available literature, that short napping periods during a shift may reduce sleepiness and fatigue; improve performance and cognitive ability; and reduce errors (Ruggiero & Redeker, 2014). In another meta-analysis review, it was found that brief, scheduled naps during shift work alleviated fatigue in shift workers, with a noticeable impact on acute fatigue and performance. Furthermore, the effects of napping on acute fatigue were modest, yet statistically significant (Ruggiero & Redeker,

2014). The authors reviewed studies that included different napping strategies, with naps lasting from 15 minutes to 120 minutes, and at different times during the shift. The authors were unable to determine which strategy was optimal. These findings suggested that short naps were an encouraging strategy for fatigue mitigation and fatigue management (Martin-Gill *et al.*, 2018). However, in a single-centre study conducted in Japan, scheduled naps were trialled among emergency medical care shift workers. The authors noted an increase in the number of night-time emergencies and, as a result of this; emergency medical care providers were attending a greater number of emergencies than their colleagues in similar industries and services. Night shift lengths were augmented in order to facilitate a napping schedule. This study included ten operational participants over three shifts (24-hour shifts with different allotted napping times and lengths). It was concluded that acute subjective fatigue was alleviated and physiological activity was affected. However, self-reported results showed that there was no perceived or marked improvement in reaction time, or a reduction in overall fatigue/sleepiness. Drowsiness, heart rate, local body pain and dullness, and oral temperatures, were also monitored. Although reports of an improvement in body aches and dullness due to napping were noted by all the participants, each shift's assigned time and length of napping did not make a significant difference to the findings. These findings may be attributed to the small single-centre study (Takeyama *et al.*, 2009). Strategies for rest and napping require further investigation, as the correct strategy must be implemented to avoid detrimental, adverse effects such as sleep inertia (Dawson, Ferguson & Vincent, 2021).

Patterson *et al.* (2017) recommended caffeine intake during shift work as a technique to mitigate fatigue (Daniel Patterson *et al.*, 2017). A systematic review by Temple *et al.* (2018) indexed data and found that caffeine intake whilst on shift improved performance (Temple *et al.*, 2018). Their systematic review showed inconsistent randomization in some of the studies (which has potential for bias); and inconsistent use of caffeine in some studies, with different amounts drunk, and inconsistencies in when it was drunk (Temple *et al.*, 2018). These variations in the use of caffeine products skewed the data; but overall, some evidence was collected on the use of caffeine. Caffeine is widely utilized. However, further education could lead to its optimal use.

In a case report, shift lengths and patterns were adjusted by Patterson *et al.* (2015). This change in shift pattern and length was to minimise the effect of fatigue on the performance of

duties during the shift. This report only included a single participant over a relatively short period of time. The result was favourable and showed a self-reported reduction in overall fatigue, and an improvement in performance (Patterson *et al*., 2015).

When considering methods for fatigue mitigation, Studnek *et al.* (2018) found limited data in a systematic review on the effective use of task-loading or work-load modification within the emergency medical care service (Studnek *et al.*, 2018). The review included publications which made use of experimental trials, randomized control trials, and quasi-experimental studies. Task-loading, or work-load modification, refers to adjusting the work load, delegating tasks, and identifying tasks that are particularly susceptible to fatigue error while on shift (Studnek *et al.*, 2018). By implementing this, perceived fatigue and fatigue-related risks are reduced. A better quality of sleep is experienced and this reduces the potential for poor fatigue recovery between shifts. The authors found these strategies differed between various emergency medical care services. Overall, the authors confirmed that, although there was only some evidence, task-load modification did lead to a perceived reduction in fatigue and improved performance and safety (Studnek *et al.*, 2018). Locally, task-load modification and fatigue mitigation may have positive outcomes for advanced life support providers. This implies modifying the shift work requirements according to the time of day or night, and the task intensity; and reducing the likelihood of tiredness and exhaustion, or of developing fatigue near the end of a shift. Further study is required on the subject of task-loading and its relationship with fatigue mitigation, specifically in the emergency medical care service.

Similar industries and services have introduced informal fatigue-mitigating practices and have achieved a level of fatigue resilience. Fatigue-mitigating practices include shift workers sharing the task at hand, by soliciting a colleague's input, or having a colleague double-check the work. This maintains and ensures performance and safety, and improves error recognition. Increasing the level of environmental stimulation is another method of fatigue mitigation; for example, listening to loud music, opening the vehicle windows, or turning the vehicle climate control to 'cold' while driving. Shift workers also eat light snacks and use tobacco products to maintain alertness (Dawson *et al.*, 2017), although tobacco products have adverse health effects causing serious disease. This may have negative implications for fatigue mitigation: Where the user already has underlying health concerns, such as high blood pressure and vascular problems, the use of tobacco products may increase their rate of

infection, and risk of cancer. This further endangers the users' health status, and therefore their ability to safely perform their duties during shift work (Wilson. K. M, Weis. E, 2011). Although these fatigue-mitigating strategies have been documented as used informally, further study is suggested to determine the efficacy of such mitigations in the emergency medical care service and the transferability from informal to formal fatigue mitigation. Locally, South African emergency medical care providers practise the above informal fatigue-mitigation strategies in an attempt to limit and overcome fatigue. However, their reported efficacy and frequency of usage is unknown.

Nationally and internationally, fatigue among advanced life support providers is a noticeable problem; yet efforts to identify and rectify this are limited. Based on an international annual longitudinal study referencing fatigue in the workplace, the prevalence of excessive day-time sleepiness in selected emergency medical care providers was recorded at 36%, and poor performance and deficits in day-time work were also reported. These included sleepiness, difficulty in recalling protocols, and a decrease in safe-driving ability (Pirrallo *et al.*, 2012).

Fatigue mitigation within the emergency medical care service should be studied further and implemented, as it is clear that reputable studies have been made available in recent years, showing positive outcomes. According to the reviewed literature, fatigue-mitigation strategies that have been trialled or implemented have been based on general informal usage by emergency medical care services and other healthcare providers, and by other high-risk, shift-working, non-emergency medical care services. Emergency medical care providers and non-emergency medical care service shift workers both share core similarities in their utilisation of informal fatigue mitigation strategies; thereby making the development of formal strategies easier to implement across industries and services.

2.13 Potential Problems

Local advanced life support providers may perceive the nature of their work as unique, stressful and unpredictable, incorporating both mental and physical demands, as opposed to other high-risk shift work that is predictable, stagnant, and less stressful. Barger *et al.* (2018) found that an attitude of bravado and cultural traditionalism, where an appearance of toughness is essential, were a potential hindrance to accurately eliciting information from their

respondents (Barger *et al.*, 2018; Ramey *et al.*, 2019). It may be anticipated that these workplace attitudes are also prevalent among local respondents. Another study found that permanently employed emergency medical care workers, as well as firefighters, were more susceptible to the effects of fatigue than their volunteer colleagues (Dawson *et al.*, 2015a). This statement similarly applies to the South African context, as this study population was comprised of permanently employed, and volunteer, advanced life support providers; and both experienced the effects and symptoms of fatigue, regardless of their employment status.

2.14 Summary

Advanced life support providers work shifts and as such experience fatigue. Consequently, they are exposed to the risks, effects and symptoms associated with fatigue. Internationally, fatigue-proofing and mitigation strategies have been implemented. Subsequently, improved health, performance and safety of emergency medical care providers at all levels have been noted. Locally safe and effective strategies for fatigue mitigation and fatigue proofing have not as yet been formalised, and current informal strategies have not been clearly defined; nor have they been evaluated within the emergency medical care service. The use of these strategies for fatigue management among South African advanced life support providers remains unknown. Therefore, research is warranted into the use of fatigue-management strategies, as used by local advanced life support providers. The following chapter outlines the research methodology and procedures used to identify and process key information in this study.

CHAPTER THREE: RESEARCH METHODOLOGY.

3.1 Introduction

The previous chapter reviewed the literature and provided insight and a broader perspective into the seminal and current subject matter on fatigue and fatigue-management strategies within the emergency medical care service and other, similar, high-risk industries and services. This chapter will explore the research design and methodology utilized to realise the aim of this study.

3.2 Research Design

Research design inherently describes the procedures for conducting a study to achieve its purpose. The study design helps to find the answers to the research questions (Maree *et al.*, 2016). The most suitable study design was descriptive and quantitative in nature. It optimised the objectives in order to focus on the study aim and address the research questions. Using a descriptive and quantitative design, allows for yielded data to determine the participants' perspectives, reflections, and interpretations rather than that of the researcher. Moreover, this design provides results based on conclusive and accurate numerical data and not subjective judgements. The study data reflects outcomes as imputed by the participants regardless of whether this data aligns with the researcher's hypothesis. What is more, the information gathered provides for quantifiable data and statistical analysis putting into perspective associations and trends. The researcher conducted a cross-sectional study using a survey tool. This design and method presented the data in such a way to best describe current local fatigue-management strategies.

Quantitative research is systematic and yields numerical data from a specific sub-group or population (Maree *et al.*, 2016). This research methodology was appropriate for the study, since the researcher was able to test interdependence between the variables. In keeping with the methodology, a descriptive non-experimental design was utilized to test the dependant variable (fatigue management) against the independent variable (number of symptoms associated with fatigue as perceived by advanced life support providers), to yield numerical data which supported an outcome. Furthermore, an evaluation of current fatigue-management

practices, not trends, was conducted. This approach compared the researcher's hypothesis for the research population against currently published literature.

3.3 Population and Sample

The population is a specific group of sampling units linked to the research question (Maree *et al.*, 2016). This general population can be further defined as the total number of distinct individuals who represent the characteristics of the population from which the target sample will be drawn. In the context of this study, the general population consisted of prehospital emergency medical care advanced life support providers working in South Africa (Maree, 2007).

A target population is defined as the individuals from whom the researcher intends to draw conclusions. Accordingly, in the context of this study, this group comprised the advanced life support providers in KwaZulu-Natal (Maree *et al.*, 2016).

Advanced life support providers were further categorised as an accessible target population. This group is defined as the actual accessible sampled group of individuals from which the researcher intends to gather data (Maree, 2007).

The accessible, sampled group was taken from the target population of advanced life support providers, as reflected in Table 3.1. This local sample was accessible to the researcher and represented the general population of advanced life support providers within South Africa, as the services they work for; the job requirements; the length of shift; and shift patterns are all alike.

Table 3.1: The target population within KwaZulu-Natal.

Name of Service	Number of ALS providers
Netcare 911 road operations and helicopter emergency medical service	33
ER24	8
Life24 emergency service	1
Meditech ambulance service	4
Crisis medical ambulance service	2
Midlands emergency medical care	4
Mi7 emergency medical care	2
Kwa-Zulu private ambulance service	4
Med-Evac emergency medical service	5
IPSS emergency medical rescue	1
Medi-Response	5
City-Med ambulance service	2
KwaZulu-Natal Department of Health, provincial emergency medical and rescue service	144
South African Red Cross/ Air Mercy helicopter air ambulance service	2
Black Eagle helicopter emergency medical service	2
Alert emergency medical services	1
Total target population of advanced life support providers in Kwa-Zulu Natal	220

Table 3.1. Source: The researcher conducted ‘’face-to-face’’, electronic, and telephonic communications with individual colleagues and other advanced life support providers within the research area on multiple occasions ensuring accuracy of the values. Where this was not possible, online searches were implemented (KwaZulu-Natal Department of Health, 2023).

The target population (Table 3.1) consisted of those who met, and those who did not meet the research inclusion criteria; hence, this group (Table 3.1) was further refined to yield an accessible population. This population numbered 86 potential respondents and embedded within this group was the actual sample (n=66) for this study; individuals who met the inclusion criteria and were willing to share their rich experiences of the research topic. Considering the geographical size of the research area, this potential group of respondents were accessible by means of electronic platforms, social media, and snowball sampling. This accessible population received and responded to the survey questionnaire.

The necessary sample size was calculated using Raosoft's sample size calculator (Raosoft® incorporated, Seattle WA, U.S.A; Raosoft, 2004), with a 95% confidence interval and a 5% margin of error, and considering a minimum 50% response rate. There were 66 participants in this study's representative sample, from a total of 86 advanced life support providers in KwaZulu-Natal who were accessible at the time of this study. Bearing in mind the response rate of the accessible sample of 86 potential respondents, and the number of completed responses, no more data was collected; so no more respondents were recruited. Data was collected to justify the probability of the hypothesis and to identify whether the associations between given variables and the baseline were not due to random chance, but were statistically significant, and due to associations between the variables themselves. This would then be representative of the general population which had a focus on patient care and worked shifts. The services of a professional statistician were used to provide guidance on the data analysis and requirements, interpretation of data and to determine the statistically significant associations between the variables.

3.4 Inclusion Criteria

Inclusion criteria included all advanced life support providers who worked shifts and were required to administer advanced life support emergency medical care treatment as part of their clinical management duties in KwaZulu-Natal. They were also registered with the Health Professions Council of South Africa. The participants' age and years of shift-work experience certainly played an important role in the management of fatigue. Thus, participants in different age categories and with various years of experience were included; and comparisons were made in these sub-groups of the sample. Finally, the potential participants had to be accessible in order to receive the online survey questionnaire.

3.5 Exclusion Criteria

Exclusion criteria included any medical healthcare personnel who were not advanced life support providers; or advanced life support providers fulfilling managerial duties who did not have a focus on patient care, or work shifts.

3.6 Study Setting

This study took place in the province of KwaZulu-Natal, South Africa. Advanced life support providers who had actively participated in operational duties, in either private or provincial emergency medical care services, were invited to participate and provide their valuable personal experience. It was important to gather data from respondents where they felt most comfortable and safe in a natural setting. For this reason, the use of an online method was optimal to ensure these vital requirements were afforded to the respondents. Online surveys allowed for relatively easy contact and distribution, maximising reach in a short time. Data storage was optimised, and total costs were low. This provided the greatest possibility for open and honest sharing of experiences (Nayak & Narayan, 2019).

3.7 Sampling Method and Methodology

A non-probability method of sampling is based on the concept of non-randomness, so that the results from the data could allow generalisation to the overall population (Maree *et al.*, 2016). This was an appropriate method for sampling, as the researcher had limited access to the general population (South African advanced life support providers). The researcher's rationale for non-probability sampling with convenience sampling is based on the known limited total number of advanced life support providers in a known limited study area where it was not suitable to the study to randomly include all categories of qualified emergency medical care service providers. Potential respondents were thus not selected randomly but rather selected, based on the stated inclusion criteria. The sampling technique used was convenience sampling, as the number of local advanced life support providers were clearly defined within the sample area and were readily accessible via electronic means. A disadvantage of convenience sampling is sampling error, or a lack of representation. Considering this potential pitfall, the researcher had selected all the advanced life support providers in KwaZulu-Natal

(the research area), within the inclusion criteria. In addition, to bolster contact with potential participants the snowball method was used.

This local sample was representative of the general South African population and, as such, transferability was possible, as the sample had shared characteristics with the national population (Maree *et al.*, 2016). (They work shifts; they have similar levels of clinical and administrative responsibility; they are advanced life support providers, and they experience fatigue.)

Research methods are the strategies and processes used in the collection of data and new evidence for analysis. They allow for the discovery of new information and a better understanding of an area of study. Therefore, the method of data collection for this study was an online survey. With the support of technology the survey was provided to the respondents in an online format. Also, this ensured anonymity, comfort during participation, and further reach to out-lying respondents. According to Maree *et al.* (2016), a survey determines the current values, attitudes, beliefs, and opinions from the known sample. A survey also allows for evaluation of multiple variables and the hypothesis may be tested too (Maree *et al.*, 2016). It may also be wide-reaching with the aid of technology, and as such the optimal method for gathering data from the sample. A questionnaire was the instrument to gather data from the respondents.

3.8 Measuring Instrument

The researcher made use of a Likert-type ordinal scale survey as the method, and a questionnaire as the instrument, to measure the participants' responses. The Likert-type formulation provided a clear ranking order to the items being questioned. The survey evaluated the effective use of informal fatigue management strategies against the effects and symptoms associated with fatigue.

The chosen design of this survey was grounded in validated fatigue and sleepiness survey measuring instruments, namely the Epworth Sleepiness Scale (Johns, 1991); the occupational fatigue exhaustion recovery scale (Winwood *et al.*, 2005); and validated questionnaire survey tools designed and used by Patterson *et al.* (2015; 2018). Fatigue

recognition and management sections were based on the surveys and focus groups conducted and designed by Bérastégui *et al.* and Patterson *et al*., respectively (Bérastégui *et al.*, 2018; Patterson *et al.*, 2018). In addition, fatigue-mitigating and fatigue-proofing sections were based on core fundamentals and themes in fatigue management guidelines that were implemented in the city of Pittsburgh in the United States of America by the National Association of State Emergency Medical Service Officials, (Patterson, Higgins *et al.*, 2018; Washington & Falls, 2018) in January 2018.

The advanced life support providers were invited to give their informed consent to participate. The survey was presented in an online format, and the respondents were able to withdraw their participation at any time. The measuring instrument was utilised in order to achieve the objectives of this study: firstly to identify and to analyse the frequency and severity of the effects and symptoms associated with fatigue, related to performance, safety, and health, as experienced by local shift-working advanced life support providers. Secondly, the efficacy of informal fatigue-mitigating and fatigue-proofing strategies that were utilized by local shift working advanced life support providers was evaluated.

The following sections of the survey questionnaire were presented to the participants to determine their experiences of fatigue and how they managed that fatigue. The sections described below were thus identified as the most effective to prompt the best responses from the participants.

The first section of the survey addressed the first objective of the study. This was to identify the impact of fatigue on the participants' performance, safety, and health. Considering this, personal experiences related to shift-work fatigue were elicited. This allowed the researcher to focus on exploring aspects of safety, such as fatigue-related errors in relation to length of shift; performance in clinical information retrieval; and self-reported health effects and symptoms, including inter-shift recovery, associated with fatigue.

The following sections addressed the second objective of the study, and evaluated the participants' ability to manage their fatigue. How did the participant adapt to and resist fatigue effectively, and with what frequency did they employ these strategies? Added to this the researcher wanted to determine if the informal techniques utilised were grounded in evidence,

education and training. Based on this, the researcher explored the participants' fatigue-management techniques; sleep education and hygiene; inter-shift recovery; diet and exercise; lifestyle habits; and the effects of environmental stimuli. Also, had the participant made preparations prior to the commencement of their shift? Did they practice self-regulation and error monitoring, and was their lifestyle conducive to the reduction of shift work fatigue? Thereafter, the questions that were posed to the participants were linked to specific techniques that were used to try and overcome and adapt to fatigue, drawn from Patterson *et al's.* study (Patterson *et al.*, 2018). It was central to the study to ascertain whether the informal fatigue management strategies were indeed effective in curbing the effects and symptoms associated with fatigue, so that the participants were able to perform safely and improve their health.

The sections described above will illustrate the participants' personal experiences that best provided insight into their self-reported effects and symptoms associated with fatigue. Moreover, they provided an insight into the role of their informal fatigue-management strategies. These stated experiences and strategies underpinned the advanced life support providers' systematic behaviour, in order to manage the likelihood or consequence of the development of fatigue.

3.9 Proof of Concept and Pilot Study Phase

The online survey questionnaire was piloted before the online roll-out to the chosen sample. The pilot phase was implemented in order to critically appraise the survey in order to ensure that the survey was an easy, ready-to-use instrument to elicit maximum data from the participants. This pilot strategy aimed to identify potential ethical and practical problems with the tool which could jeopardise the study. Additionally the pilot study process determined the time taken to complete the survey. This ensured that the online questionnaire interface was user friendly, clear and concise; and that the online system worked. Advanced life support providers from provinces other than KwaZulu-Natal were invited to participate in the pilot study. The potential respondents were known personally to the researcher and were contacted directly in their personal capacity. They were chosen using random convenience sampling, with a minimum of 14 participants completing the pilot survey. The respondents from the pilot study received the same survey link and survey that the respondents taking part

in the study would receive. After the pilot study, it was found that no changes were required in order to streamline the process, and less time was required to complete the survey than had been anticipated. Notably, the pilot survey phase was treated with anonymity and confidentiality, moreover, participation was voluntary. The same guiding ethical considerations were adhered to. No responses and data that was captured during the pilot study was analysed, but rather the feedback from the participants was assessed for ease of use and understandability including the above-mentioned qualities required.

3.10 Data Collection Strategy and Procedure

Considering the design of this study, data and information-gathering methods included sourcing information from relevant literature; the pilot study, as discussed above in Section 3.9; and the survey tool which was used to collect numerical data that provided locally relevant evidence. An online survey questionnaire (Appendix D), (QuestionPro® Inc., Bhaskaran. V, Austin, TX, U.S.A), (QuestionPro, 2005) was used to gather data. Additionally, an information letter (Appendix B) and a consent letter (Appendix C), with links to the survey, were distributed to all respondents by email and on other electronic platforms. After reading the information letter, each potential respondent was given an opportunity to access the link to the survey and, by following the survey link, consent was provided by the participant. If the respondent had declined consent, then the survey was terminated at that point. The participants were then able to complete the survey in their own time and in privacy where they were most comfortable.

To maximise reach throughout the KwaZulu-Natal province, snowball sampling was used. This method was used to contact additional advanced life support providers. Next, personal contacts and other providers known to the researcher were emailed or contacted through various electronic platforms such as electronic social media groups including ‘’Telegram®’’, or ‘’WhatsApp®’’, directly. Added to this, individual correspondence among potential participants was encouraged and used with the aim of distributing the survey link requesting their participation. Simultaneously, contacts known to the researcher were also asked to forward and request participation from colleagues known to them. Building on this, a colleague’s data base containing advanced life support provider contact details, various social/professional

platforms, and forums, was used, via the database-owner, without researcher exposure to the database content, to request participation in this study.

These strategies allowed the researcher to invite participation and distribute the information letter and consent letter with a link to the survey via email, and other electronic platforms. Reminder emails were also sent to the participants to ensure the best possible response rate; after two weeks, and again after four weeks.

3.11 Data Analysis

A professional statistician was engaged to analyse the data. The data was recorded descriptively. The reported effects and symptoms associated with fatigue were correlated with international published literature. The ordinal scale survey format provided scoring for data interpretation, based on validated guidance and scoring scales of the Epworth sleepiness scales (Johns, 1991), and the occupational fatigue exhaustion recovery scale (Winwood *et al.*, 2005). This allowed for congruence between the participants' personal experience of fatigue, and confirmation whether the fatigue-management strategies were effective or not.

The results from the Likert-type scale allowed for the generation of a score: the higher the score, the higher was the likelihood that the participant was experiencing fatigue, or had been affected by a specific aspect of fatigue. These scores, in combination with the definitive response (yes or no) to whether or not the participant was experiencing fatigue, and their effective use of informal fatigue management strategies, alluded to greater susceptibility or resistance to the consequences of shift work-related fatigue.

Additionally, the IBM SPSS Version 27 (IBM Armonk, NY, U.S.A) was utilised to analyse the data. Descriptive statistics were presented in frequency tables with numbers and percentages of participants. Associations between variables were tested using cross-tabulations of the variables. Fisher's exact two-sided test was used when binary-by-binary or ordinal-by-binary responses were tested, such as testing for statistical significance within a limited data set (statistical significance value p=0.05). Spearman's rho was used for ordinal-by-ordinal variables which validated the associations between participant perceptions, behaviours and fatigue management strategies (Maree, 2007). As described above, descriptive analysis then

compared the results yielded from the data with the researcher's hypothesis and the existing published literature. Thus the significance of the successful management of the effects and symptoms associated with fatigue, versus the efficacy and frequency of the use of informal fatigue management strategies, was evaluated and presented.

3.12 Delimitations and the Scope of the Study

The delimitation of a field of study refers to the characteristics which limit the scope and define the boundaries (Maree *et al.*, 2016). Limiting factors included the researcher's selection of objectives, the research question, and the population selected for evaluation. Consequently, to facilitate the evaluations of this study, this research was conducted in the South African province of KwaZulu-Natal.

Limitations in this study included the cross-sectional design, which looked at the temporary nature of associations, or causative relationships, between fatigue and fatigue management outcomes which, therefore, could not be inferred or examined in a linear fashion but rather at a fixed time-point (Maree, 2007). Moreover, fatigue is dynamic and changes with time, provider experience, and environmental conditions (Ramey *et al.*, 2019). Convenience sampling might be disadvantaged by sampling error or a lack of representation. A lack of representation may be seen in literature with small single centre studies or studies done with small niche groups. This was overcome by having available an exact number of advanced life support providers in KwaZulu-Natal. Snowball sampling was used in conjunction with convenience sampling as an additional strategy to reduce potential limitations and to maximise participation among potential respondents who met the inclusion criteria.

Online surveys may produce low response rates and respondents may lack interest in participating; and for this reason, the study might not be generalised to the overall population. To overcome this limitation, respondents were sent reminder notifications. An additional limitation to this study was the self-reporting method of gathering data from the respondents. This is an imperfect system, but has been used frequently (Nayak & Narayan, 2019). Data that has been gathered in this method allows the respondents to provide their own valued input. Central to this study was the respondents' perceived experience of fatigue and the extent to which their informal fatigue management efforts were effective.

Some participants may have been disinclined to participate, as acknowledging fatigue has negative connotations in terms of job performance and status of the individual. To resolve this, complete anonymity was ensured. The advantageous use of an electronic survey imparted a sense of safety and confidence, which ensured complete anonymity for the respondents, encouraging them to provide their own valued experiential input.

This research was conducted in KwaZulu-Natal and, as such, data was sought only from local advanced life support providers. Individuals from private emergency medical care services, and the provincial emergency medical care service, who met the inclusion criteria in this region were invited to participate. This chosen population had greater responsibilities and more complex capabilities in their independent clinical practice, compared with their Intermediate and Basic Life Support colleagues (Department of Basic Education, 2014; Health Professions Council of South Africa, 2018a). For this reason they were at greater risk of developing and working in a fatigued state which may have been posed a threat to safe practice (Cash *et al.*, 2020).

3.13 Validity and Reliability

Validity is the ability for the research to be conducted in another location, or by another researcher, with the same results yielded consistently; as well as the measurement of data that relates directly to the research (Maree *et al.*, 2016). This is important, due to the need for credibility of the research so that the results may improve provider and patient safety and fatigue management in future research, as well as the experiences of advanced life support providers. Control of internal validity was ensured by upholding the participant inclusion criteria and not allowing deviation from it. Regarding data analysis, the instrument and method for data collection was consistent, statistical control was maintained which ensured consistent and appropriate statistical analysis. External validity was maintained by controlling external variables. Participants were all provided with identical survey questionnaires, the instructions and information that they received was also identical. All participants engaged in the survey when they felt most comfortable and safe thus, situational variables were constant during the survey engagement process. In view of the above, manipulations, changes, causes, or potential influencing factors were considered in order to limit risk to validity.

Reliability is the extent to which the measuring tools are repeatable and consistent (Maree *et al.*, 2016). This was ensured by using previously validated fatigue-measuring, management, sleepiness, and fatigue-recovery tools. The questions formulated were guided by the reviewed literature and already-validated survey questionnaires. The ordinal scale and closed question formulation of the survey questions provided the researcher with frequency and usage data. The online survey questionnaire was piloted initially in order to be critically appraised and ensure reliability. Data reliability testing included internal consistency, content validity, and face validity. Ensuring reliability, this confirms the re-testability and consistency of the measuring tool and the validity of the yielded data.

3.14 Anonymity and Confidentiality

Anonymity and confidentiality are essential to protect each participant from any negative repercussions during the acquisition of the data, and to prevent any potential bias within the research itself. Anonymity further encourages participation as it affords the participant privacy and allows for honest responses. The measurement tool (Appendix D) indicated specifically that the participant should not provide any identifying information for the record; and the researcher did not divulge the identity of the participants in the subsequent research presentation, thus maintaining anonymity and confidentiality. During the snowball sampling process, in order to avoid encroaching on potential participants' privacy, the researcher asked existing participants to first obtain permission from their referred colleagues for the researcher to contact them, further maintaining confidentiality. The use of QuestionPro® online survey further safeguarded anonymity and confidentiality added to this, no personal information was requested. QuestionPro® conforms to international ethical and confidentiality requirements. At no point during the data acquisition phase was personal information obtained or recorded.

3.15 Ethical Considerations

This study had social value as it had not yet been researched within the context of the South African emergency medical care service. Furthermore this study added scientific validity, as validated tools were used. Bearing scientific rigour in mind, the use of a pilot study validated the design of the measuring instrument. The validity and reliability of the results were assessed, and it was ensured the data was interpretable and useful within a local context.

The researcher ensured fair selection, as all local advanced life support providers who met the inclusion criteria were asked to participate, which ensured maximum benefit. As collective partnerships between local services exist, all participants and their employers should, potentially, benefit from the research outcomes. There were favourable risk-benefit ratios with limited potential for harm, considering the privacy benefits of the online format. Potential for benefitting the participants existed. This included making effective fatigue management strategies and suggestions available (Emanuel E, Wendler D, 2008).

Respect for the participant, anonymity and confidentiality were addressed and maintained as all online and electronic data collected was stored on a password-protected platform where the researcher was the only one with access. In addition, the identities of the participants could not be divulged to anyone at any point in time, as the survey was completely anonymous and online. Had an individual at risk of self-harm or harmful behaviour approached the researcher for assistance during the course of this research, an arrangement to offer support and counselling without any need for identification was available. Prior to the commencement of the study, a psychosocial support structure was identified and would provide this support, through life-style education or medical intervention, if needed.

For the purpose of fair and independent review the research was assessed and approved by an ethics committee at the Durban University of Technology to ensure ethical integrity. This study was then allocated an ethics clearance number: IREC 208/21 (Appendix A). A letter about the purpose of the study (Appendix B) also indicated that participation was on a voluntary basis. The online survey (Appendix D) was distributed by means of email and other electronic platforms via electronic social media groups, including ‘’Telegram®’’, ‘’WhatsApp®’’, and individual correspondences among potential participants, with the information letter (Appendix B). Individual informed consent (Appendix C) was gained when the respondent opened the link to the online survey. The aim and objectives of this study were to reflect on the individual’s personal experiences and management strategies related to fatigue. Participant recruitment was done on a personal contact basis from the researcher, added to this; further recruitment requests were made among colleagues. Participants were approached in their private capacity; so gatekeeper approval was not required and approved as such by the Ethics committee.

3.16 Summary

This chapter has outlined the study design, methodologies, and strategies used in order to substantiate this study. Moreover, it has presented the rationale for the instrument used and for the selection of the participants. The following chapter will present the results from the data collected, in keeping with the objectives of the study.

CHAPTER FOUR: RESULTS.

4.1 Introduction

This chapter presents the results and findings obtained from the survey questionnaire used in this study, which were then considered and analysed to address the study objectives. The informal fatigue management strategies practised by the participants were explored and considered, along with their experience of fatigue.

4.2 Demographic Profile of the Participants

Emails, electronic media platform communications such as electronic social media groups including ‘’Telegram®’’, ‘’WhatsApp®’’, and individual correspondence among potential participants were used with the aim of distributing the survey link to all 220 potential participants. In total 134/220 (60.9%) of potential participants received, viewed and immediately terminated the survey (Appendix D), either from lack of interest or because they met exclusion criteria. From the total target population the accessible population numbered 86. All 86 accessible participants responded to the online questionnaire. However, once they had read the information letter (Appendix B), 20/86 (23.3%) were ineligible to continue as they did not meet the inclusion criteria or they had viewed, started, and terminated the survey prior to completion. A total of 66/86 (76.7%) participants met the inclusion criteria and completed the survey questionnaire. This gives an overall response rate of all potential respondents who both met and did not meet the inclusion criteria of 30.0% (66/220), which is still an acceptable value in terms of study validity.

Participants were requested to provide the following demographical data: age, sex, and length of time (in years) that they have been operational as an advanced life support provider. The demographic profiles of the participants are presented in Figures 4.1 and 4.2.

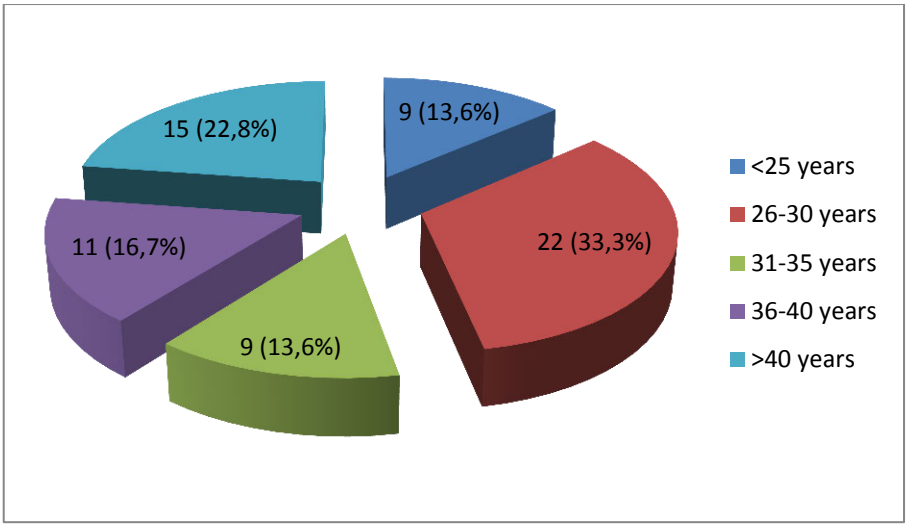

Figure 4.1: Age categories of the participants

Figure 4.1 shows a breakdown of the age categories of the participants, with 22/66 participants being in the predominant age group between 26 and 30 years of age, and with 15/66 (22.7%) participants in the over 40 years of age group. The sex distribution demonstrated that 45/66 (68.2%) participants were male.

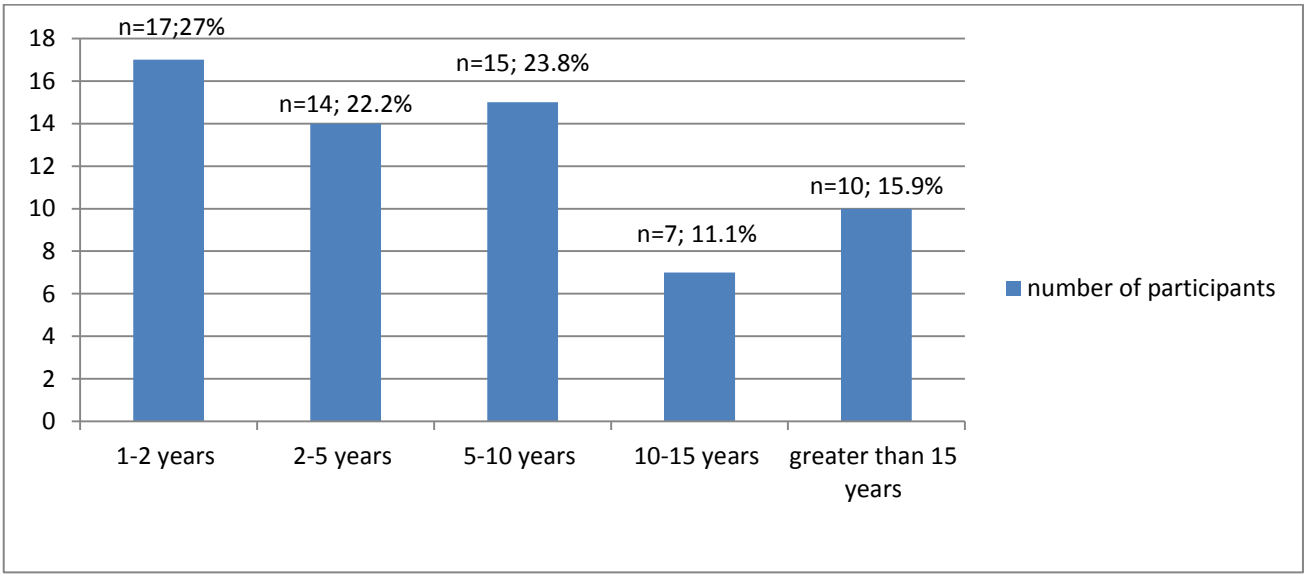

Figure 4.2: Years of experience as an advanced life support provider

Figure 4.2 shows the participants' years of experience, and indicates a greater number (17/63; 27%) with one-to-two years of experience, and five-to-ten years of experience (15/63;

23.8%). It can also be noted that 32/63 (50.8%) of the participants had over five years of experience. Three participants elected not to answer this question.

4.3 Advanced Life Support Providers': Length of Shift Effect on Clinical Errors and Safety Concerns

In order to gauge the amount of time the participants spent on duty, they were asked to indicate the length of their shift, and if this length of shift time had an effect on their levels of fatigue. Two participants did not answer this question. With reference to shift length, the majority, 49/64 (76.6%), of the participants worked 12-hour shifts; while 20/65 (30.8%) of participants worked 24-hour shifts. More than half, 36/66 (54.5%), of the participants worked standby shifts in addition to 12-hour day shifts. Standby shifts consist of the participant working a continual shift, day and night, often up to 48 hours, and they are dispatched when needed. Some of the participants also worked a regular 12-hour day shift followed by standby shift duty through the night.

Participants were then asked to provide input on their potential for clinical management errors, and whether their patients', or their own, safety was compromised as a result of their length of shift. Thus, 55/66 (83.3%) participants indicated that they had not made clinical management errors in the last month and 11/66 (16.7%) indicated they had made clinical management errors, while 42/65 (64.6%) participants reported that their personal or their patients' safety was 'occasionally' compromised by way of fatigue. One participant did not answer this question on provider or patient safety.

Cross-tabulations and Fisher's exact two-sided test were used to compare and to determine the relationship between length of shift, with outcomes of clinical management errors and patient safety compromise. These cross-tabulations and tests revealed that participants who worked 12-hour shifts were more likely to make clinical errors (20.4% vs 6.7%), but this finding was not statistically significant ($p=0.434$). Those who worked 24-hour shifts were also more likely to make clinical errors (25% vs 13.3%). This, too, was not statistically significant ($p=0.292$). Those who worked standby shifts were also more likely to make clinical errors (22% vs 10%), but this was also not statistically significant ($p=0.320$). The participants' length of shift did not appear to impact on clinical management errors or provider and patient safety. Although not statistically significant, an interesting outcome; the basis of the above section had compared a relationship between length of shift, with outcomes of clinical management

errors and patient safety compromise and concluded that more participants felt that they had not made clinical management errors, nor placed themselves or their patients in harm while on shift and as a result of fatigue, regardless of their length of shift.

4.4 Clinical Performance, Information Retrieval and Processing

Clinical information retrieval and critical thinking is a vital aspect of emergency clinical management and care. In order to provide optimal patient care, the advanced life support provider is required to critically assess the patient and this requires clinical information retrieval and processing. Here the questioning sought to establish fatigue-related effects and symptoms that the participant was experiencing, focussing on exploring clinical information retrieval. The largest proportion of participants (38/65; 58.5%), felt that only ‘occasionally’ did fatigue adversely affect their clinical management decision making. None of the participants felt that fatigue ‘always’ affected their clinical management decision making.

Similarly, a large group (32/66; 48.5%), of participants felt that it was ‘occasionally’ increasingly difficult to retrieve information as the shift progressed; while 19/65 (28.8%) participants felt that they ‘never’ experienced this difficulty. The participants’ ability to make clinical decisions efficiently was evaluated and compared to their ability to retrieve and process information adequately as their shift progressed.

Figures 4.3 and 4.4 show the participants’ responses to questions about how often fatigue affects clinical decision making and their ability to retrieve information safely, as their shifts progress. They show that the majority of the participants felt these effects of shift duty on an ‘occasional’ basis.

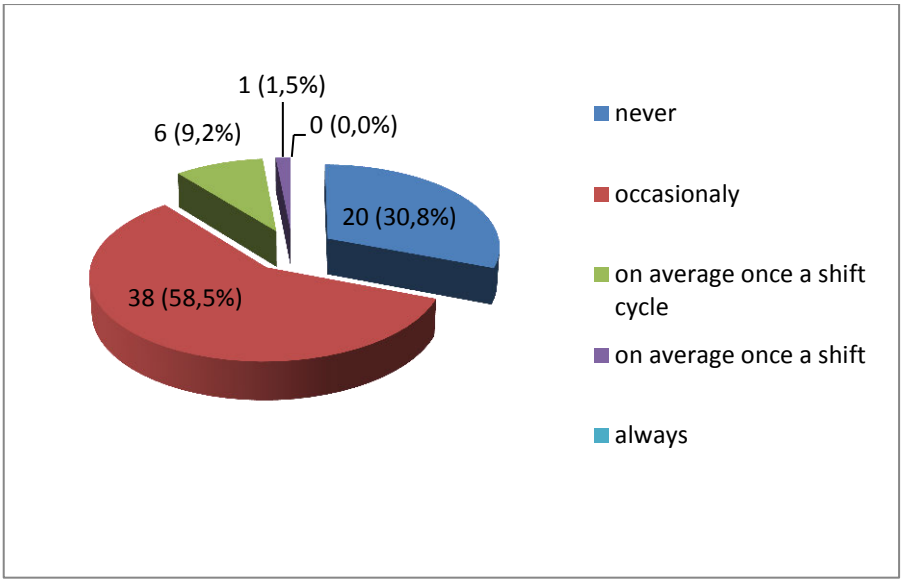

Figure 4.3: Impact of fatigue on clinical decision making

Figure 4.3 highlights 38/65 (58.5%) participants had ‘’occasionally’’ felt the impact of fatigue on clinical decision making.

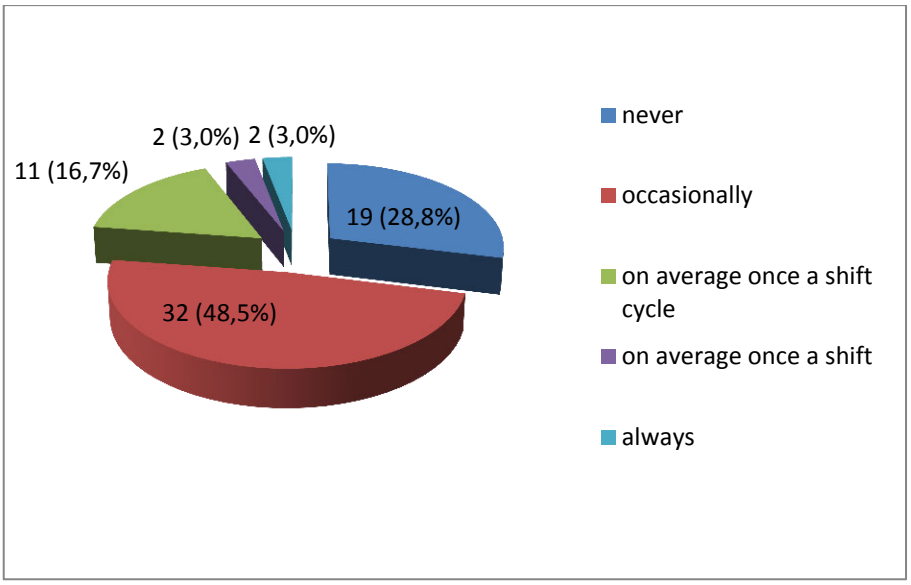

Figure 4.4: Difficulty in information retrieval and processing

Figure 4.4 shows 32/66 (48.5%) participants ‘’occasionally’’ had difficulty in information retrieval and processing.

These variables above were cross-tabulated, and Spearman's rho for ordinal-by-ordinal variables was used to assess whether there was an association. There was a significant positive correlation between those participants who felt that it was increasingly difficult to retrieve and process information as their shifts progressed, and to make clinical management decisions efficiently (rho = 0.480, p <0.001) as a result of shift work-induced fatigue. Therefore, this positive association indicated that the participants that were least affected by fatigue were less likely to find it difficult to process information as their shift progressed.

4.5 The Impact of Fatigue on the Advanced Life Support Providers' Health, Regular Lifestyle Habits, Inter-Shift Recovery, and Behaviour

Advanced life support providers work shifts and, as in all shift work, they have off-duty days. The participants were asked about their plans and off-duty experiences, related to their regular lifestyle habits (for example: socialising, eating, and exercising). Furthermore, participants were asked whether fatigue interfered with their personal health; if they were able to recover adequately between their shifts; and if their physical energy levels were affected. Once these variables had been tabulated, the researcher also determined if they were able to identify the effects and symptoms associated with fatigue affecting the above.

Most participants (41/66; 62.1%) responded that fatigue 'occasionally' prevented them from fulfilling their off-duty plans, while nearly all (62/66; 93.9%) the participants were able to identify the effects and symptoms associated with fatigue. On comparing these two variables, a significant association was noted between the participant being unable to achieve their off duty plans and the ability to identify the effects and symptoms associated with fatigue (p=0.025).

Table 4.1: Fisher-Freeman-Halton Exact Test: Association between participants being unable to achieve off-duty plans and the ability to identify the effects and symptoms associated with fatigue.

	Value	Exact Sig. (2-sided)
Fisher-Freeman-Halton Exact Test	7.523	P= 0.025
No. of Valid Cases	66	

The results of the Fisher-Freeman-Halton exact test, shown in Table 4.1, indicates the significant association (P=0.025) between these two variables. This indicates they were unable to achieve their off-duty plans as a result of fatigue. Therefore, the participants identified the effects and symptoms associated with fatigue as the causative factor. Those 22/66 (33.3%) participants who felt that fatigue 'always' prevented them from achieving their off-duty plans, were most likely to not know the symptoms of fatigue. Figure 4.5 represents the frequency with which the participants felt fatigue prevented them from achieving their off-duty plans, which essentially plays an important role in the advanced life support providers' quality of rest and recovery.

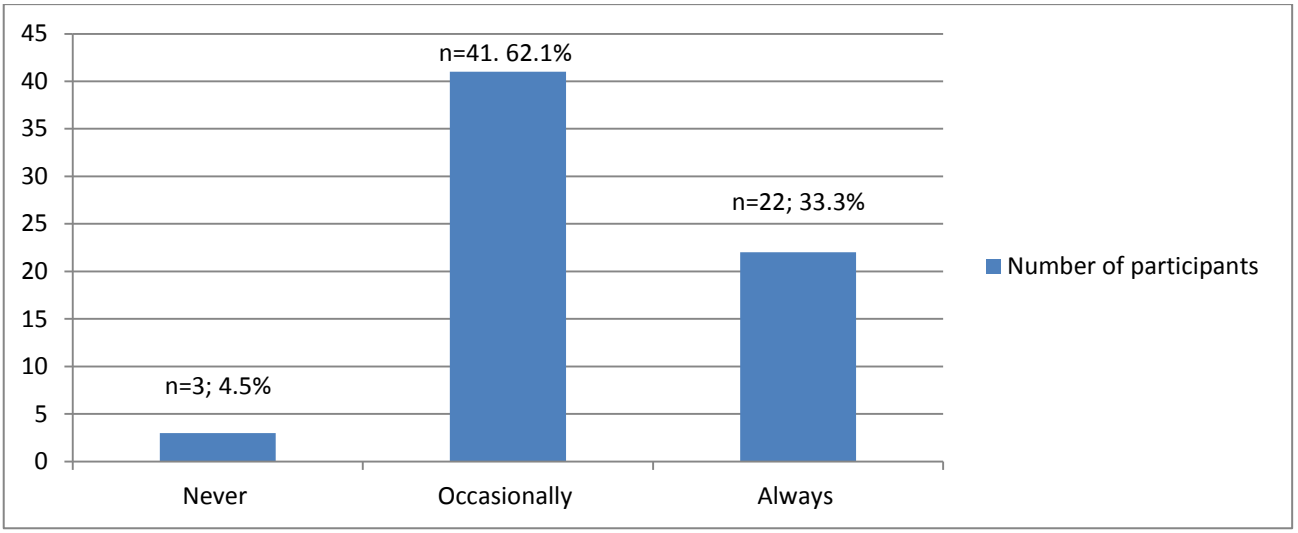

Figure 4.5: How often fatigue prevents the participants from achieving their off-duty plans

Almost half (32/66; 48.5%) of the participants specified that they experienced health symptoms and 16/65 (24.6%) participants agreed that fatigue interfered with their regular lifestyle habits at least 'once between' their shifts. Those who were likely to agree that fatigue affected their health were also more likely to agree that fatigue prevented them from following regular lifestyle habits, and vice versa. Spearman's rho (Table 4.2) and cross-tabulation show a slight positive correlation between the participants' health and their inability to follow their regular lifestyle habits, which was marginally statistically significant (rho = 0.253) (one participant did not answer). Thus participants' health was affected by their inability to follow their regular life-style habits, suggesting that ill-health was amplified by limited rest and recovery and, as a result, experiencing fatigue.

Table 4.2: Spearman's rho: Correlation between participants' health and regular lifestyle habits.

How often do you have symptoms such as headaches, visual disturbances, temperature dysregulation, or sleepiness?	How often, in your opinion, does fatigue interfere with your regular lifestyle habits? (this may include socialising, eating, and exercising)	
	Correlation Coefficient	0.253
	Sig. (2-tailed)	0.042
	N	65

Only four of 66 (6.1%) participants were unable to identify symptoms of fatigue and these were proportionately more in the group who 'always' had health symptoms (5/66; 7.6%). The Fisher-Freeman-Halton exact test (Table 4.3) demonstrates the association between being able to identify the effects and symptoms associated with fatigue, and the health effects experienced as a result. There was a significant association between these variables with a p value of 0.035.

Table 4.3: Fisher-Freeman-Halton exact test: Association between being able to identify the effects and symptoms associated with fatigue and experienced health effects.

	Value	Exact Sig. (2-sided)
Fisher-Freeman-Halton exact test	8.030	P= 0.035
No. of Valid Cases	66	

Regarding the health effects experienced by participants, 32/66 (48.5%) of participants 'occasionally' experienced health effects as a result of fatigue. Moreover, 11/66 (16.7%) participants indicated they experienced health effects 'on average once a shift cycle' and 10/66 (15.2%) participants experienced these effects at least 'on average once a shift'. Of the participants, 13/65 (20.0%) alluded to fatigue interfering with their regular lifestyle habits 'on average minimally in-between their shift cycle'; and 16/65 (24.6%) commented that fatigue

interfered with theirs ‘on average once in-between shifts’. Almost all the participants (62/66; 93.9%) were able to identify the effects and symptoms associated with fatigue.

Thirteen of 66 (19.7%) participants indicated they ‘never’ felt adequately recovered between their shifts and 44/66 (66.7%) felt only ‘occasionally’ adequately recovered. Sixty-two of the 66 participants were able to identify effects and symptoms associated with fatigue. Cross-tabulations with Fisher-Freeman-Halton exact test demonstrated no association between limited inter-shift recovery and being able to identify effects and symptoms associated with fatigue (p=0.254). Interestingly, a slight trend towards a positive association was noted among those 13/66 (19.7%) participants who ‘’never’’ felt adequately recovered, and those 4/66 (6.1%) who most probably did not know the symptoms of fatigue.

No association was noted between lacking physical energy and being able to identify symptoms of fatigue (p=0.505), while among the participants who experienced a lack of physical energy, this showed some correlation with being unable to achieve regular lifestyle habits. However, this just missed being statistically significant (Rho 0.244). Thus putting the data into perspective, by means of cross tabulation, 38.7% of the participants who both lacked physical energy 32/66 (48.5%) and felt that fatigue had interfered with their regular lifestyle habits 19/65 (29.2%), had perceived these effects and symptoms associated with fatigue on an ‘occasional’ basis.

Lastly, the participants were asked to report on specific behaviour related to fatigue. Their levels of empathy, frustration, irritability and hastiness were measured against whether they felt they could do more for their patients. The data did not suggest that fatigue impacts on the interaction between participant behaviour and patient interaction (Rho = 0.136, p=0.277). Overall, the results demonstrated that the participants felt comfortable with their behaviour and their patient interaction, which was not affected by fatigue.

An analysis of the above data, based on the participants’ reported frequency and severity of the effects and symptoms associated with fatigue, revealed that the associations that were identified particularly involved the participants’ health, lifestyles, and fulfilling of off-duty plans. Regarding the participants’ performance and safety, their length of shift did not appear to impact on clinical management errors or on provider and patient safety. However, as the

participants did not rest and recover adequately during their off-duty periods, it is likely that they started their on-duty shift period in an already-fatigued state, which may have been compounded by their length of shift. As a result, fatigue, and not the length of shift alone, led to clinical errors and safety concerns. Certainly, fatigue affected the advanced life support providers in aspects of their shift work and their lives, as indicated by their personal experiences. In view of the above, evaluations of the yielded data had also determined the participants' management strategies that were utilised in limiting their fatigue.

4.6 Advanced Life Support Providers' Years of Experience Related to their Ability to Limit the Effects and Symptoms Associated with Fatigue

Central to this study is the evaluation of fatigue management strategies. Logically, as the participants gather years of experience, they should be able to anticipate and limit the effects of fatigue. The participants were thus asked to report their age and how many years' experience as an operational advanced life support provider they had. Most participants (17/63; 27.0%) were in the 1 - 2 year experience category; followed by (15/63; 23.8%) participants with 5 - 10 years of experience. Three participants did not answer this question. Based on their experience, they were then asked whether they agreed that their fatigue management strategies improved their focus, motivation, and pro-activeness (Figure 4.6). Most participants indicated that their fatigue management strategies did, indeed, improve their focus, motivation, and pro-activeness. However, 25/66 (37.9%) participants only felt this on an 'occasionally when used' basis, while 20/66 (30.3%) indicated on an 'always when used' basis.

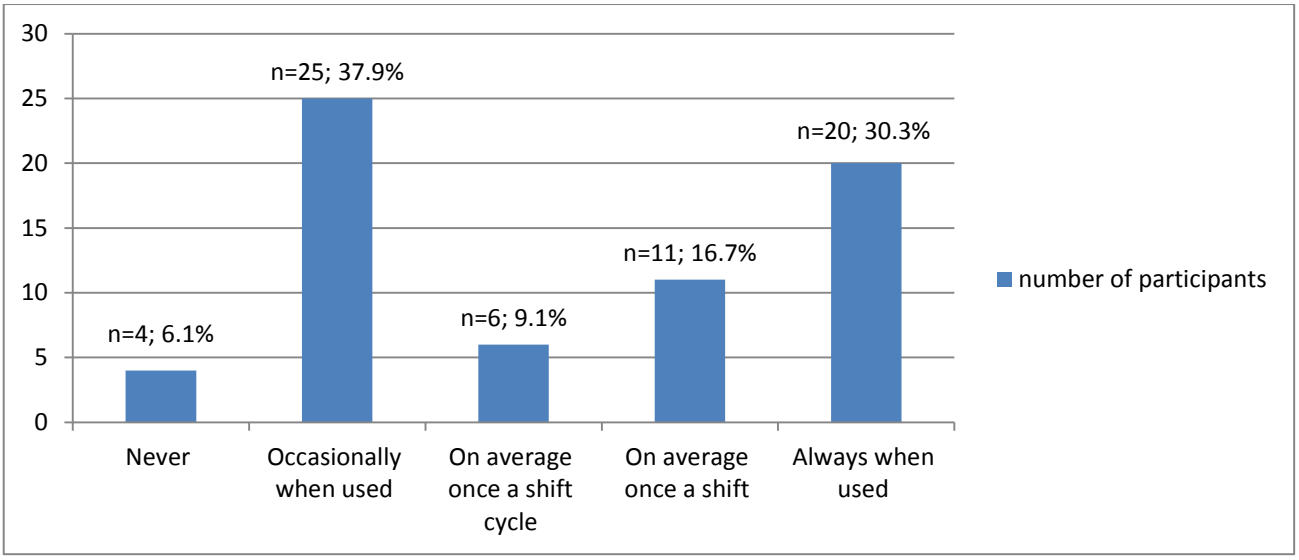

Figure 4.6: Successful fatigue management strategies improving focus, motivation, and pro-activity

These questions sought to uncover whether, indeed, there was an association between years of experience and ability to manage fatigue. There was a weak positive correlation between years of experience and ability to manage fatigue (rho = 0.297), which was statistically significant (Table 4.4). This means the more their years of experience, the more likely they were to agree that fatigue management improved their focus, motivation, and pro-activeness, and vice versa. The Spearman's rho table (Table 4.4) shows the association between the participants' years of experience and their ability to limit fatigue to improve their focus, motivation, and pro-activeness.

Table 4.4: Spearman's rho: Association between the participants' years of experience and their ability to limit fatigue

Do you agree that your fatigue management strategies improve your focus, motivation, and pro-activeness?		
How many years' experience as an advanced life support provider do you have?	Correlation Coefficient	0.297
	Sig. (2-tailed)	0.018
	N	63

4.7 Fatigue Management Strategies, Fatigue Mitigating and Fatigue Proofing

Participants had the opportunity to report on specific fatigue-mitigating and -proofing strategies affecting their ability to manage their fatigue. Fatigue-mitigating strategies that were utilised included, but were not limited to: task-loading; delegation; use of reference materials related to patient care; intensely focusing on tasks; utilising caffeine products; and taking naps/rest periods.

Nearly half 32/66 (48.5%) of the participants ‘always’ delegated responsibility and 18/66 (27.3%) participants on an ‘occasional’ basis. Many participants, 40/66 (45.5%) would ‘’occasionally’’ and 10/66 (15.2%) would ‘always’ leave less urgent tasks to either be managed in hospital or by a colleague. Of the participants, 28/66 (42.4%) ‘occasionally’ verbalised to their colleagues that they felt tired so that their colleagues would pay more attention to their actions. Contrasting this, 22/66 (33.3%) participant ‘never’ verbalised how they felt. Forty six of sixty six participants, 46/66 (69.7%) reported that they ‘always’ focused intensely on a task. A small number of participants (4/66; 6.1%) indicated that they reviewed or utilised manuals and patient care algorithms (patient treatment flow charts) ‘on average once a shift’, when treating patients; and 36/66 (54.5%) participants did so on an ‘occasional’ basis in order to avoid making mistakes as a result of fatigue. What is more, 48/66 (72.7%) participants ‘always’ double checked their medication choice and dosage before administering to a patient where 13/66 (19.7%) did so on an ‘’occasional’’ basis.

Well-known strategies were also explored, such as making use of caffeine products, a quick snack, or opportunistic naps/rest periods in order to re-energise or to reduce the effects and symptoms associated with fatigue. A large proportion of participants (19/66; 28.8%) indicated that they consumed caffeine products or a quick snack ‘multiple times per shift’ (Figure 4.7). Curiously, there was no association between being able to identify the symptoms of fatigue and making use of caffeine products or quick snacks to relieve the effects of fatigue ($p=0.416$). It appeared that those who knew what the effects of fatigue were, were equally as likely, or unlikely, to make use of caffeine products or a quick snack; while those who did not know about the effect of fatigue were most likely to make use of caffeine products or a quick snack.

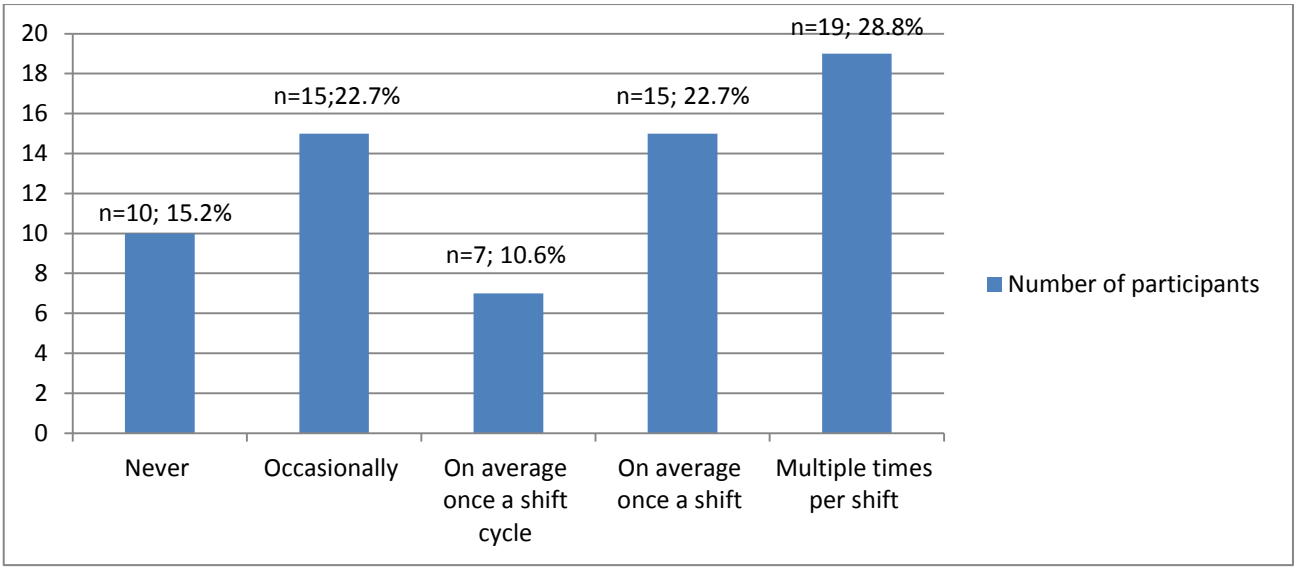

Figure 4.7: Frequency of use: caffeine products or a quick snack to re-energise

During their shift periods, in order to re-energise, 27/65 (41.5%) participants felt it necessary to take opportunistic naps/rest periods and reported the frequency as 'occasionally'; while 15/65 (23.1%) reported a 'once per shift' frequency. Moreover, where the participants took opportunistic naps/rest periods to re-energise, there was no association between being able to identify the symptoms of fatigue, and taking naps/rest periods (p=0.865). Although one participant did not answer, there was a slight trend towards those unable to identify the symptoms being less likely to take naps/rest periods. In conclusion, participants were not actively utilising naps/rest periods as part of a fatigue-mitigating strategy.

Fatigue-proofing strategies play an essential role when preparing for shift work that may often be lengthy and unpredictable. Strategies that were utilised by the participants and evaluated included sleep hygiene/education; avoiding heavy meals prior to the start of their shift; regular exercise; adequate rest and recovery between shifts; and utilisation of environmental stimuli. Adequate rest and recovery when off-duty are beneficial to the health, safety, and performance of the advanced life support providers. The researcher thus further explored whether the participants were informed about sleep hygiene/education and whether this had an impact on their fatigue management. Considering the frequency with which the participants reported feeling adequately rested, and fatigue impacting on their off-duty plans and regular lifestyle habits, identifying whether the participants were trained or educated in sleep hygiene would be beneficial as a proofing strategy to manage fatigue. Added to this, the researcher

attempted to establish whether the participants were actually utilising these strategies effectively.

A majority of the participants (36/66; 54.5%) answered ‘no’ to the question pertaining to knowledge of sleep hygiene, which revealed a lack of training, or minimal appropriate knowledge of sleep hygiene. The cross-tabulations indicated that, of those 30/66 (45.5%) participants with adequate knowledge of sleep hygiene/education, 9 (30.0%) had felt that they were ‘always’ rested; whilst of those participants without adequate knowledge, only 1 (2.8%) participant felt satisfactorily ‘always’ rested, (p=0.011). There was, nonetheless, a significant association between knowledge of sleep hygiene and the participants’ fatigue management. This indicated that knowledge of sleep hygiene was, indeed, an effective strategy to limit shift-work fatigue and enrich off-duty time and regular lifestyle habits. The Fisher-Freeman-Halton exact test (Table 4.5) shows the significant association between knowledge of sleep hygiene and successful fatigue-management strategies.

Table 4.5: Fisher-Freeman-Halton exact test: Association between knowledge of sleep hygiene and successful fatigue management strategies

	Value	Exact Sig. (2-sided)
Fisher-Freeman-Halton Exact Test	12.672	P= 0.011
No. of Valid Cases	66	

Of the participants, 25/65 (38.5%) felt that by avoiding a heavy meal prior to the commencement of their shift they would reduce the likelihood of developing fatigue. Many of the participants, namely 28/66 (42.4%), exercised ‘occasionally’. However only 19/66 (28.8%) indicated that they ‘always’ exercised.

Of the participants, 25/66 (37.9%) described their experience of ‘occasionally’ feeling adequately rested and ready prior to the commencement of their shift and 12/66 (18.2%) participants indicated ‘on average minimally in-between my shift cycle’ which was a lower frequency of feeling adequately rested and ready. Bearing this in mind, the participants’ limited rest and recovery time may have exacerbated the effects and symptoms associated

with fatigue. Advanced life support providers often utilised environmental stimuli in an attempt to manage their fatigue. Some strategies included going outside for fresh air or a tobacco product. Twenty-five of 66 (37.9%) of the participants utilised this strategy ‘multiple times per shift’; while nearly half 32/66 (48.5%) of the participants also reported listening to loud music while driving; having the air conditioning set to ‘cold’; or having the windows open for fresh air while driving, ‘multiple times per shift’. The cross-tabulation between utilising environmental stimuli and feeling adequately rested and ready revealed that, for those 32/66 (48.5%) participants who utilised environmental stimuli / factors ‘multiple times per shift’, eight of these participants ‘never’ felt adequately rested and ready before their on-duty shift cycle started. Thus, the utilisation of environmental stimuli namely; going outside for fresh air or a tobacco product, listening to loud music while driving, having the air conditioning set to ‘cold’; or having the windows open for fresh air while driving to aid in managing fatigue was evaluated against the participants’ reports of feeling adequately rested and ready prior to the commencement of their shift.

The data revealed that those 10/66 (15.2%) participants who were always rested and ready before shift, were less likely to listen to loud music or have air conditioning set to ‘cold’ or have the windows open while driving. There was a negative correlation, which was statistically significant, for the association between feeling adequately rested and ready prior to the commencement of their shift, and utilising environmental stimuli/other factors to manage their fatigue (rho = -0.429) (Table 4.6). This is also an added safety component, allowing the advanced life support provider to focus more intently, with less distraction, while driving to the scene of the emergency.

Table 4.6: Spearman's rho: Association between feeling adequately rested and ready prior to the commencement of shift and utilising environmental stimuli/ factors

Are you adequately rested and ready before your shift cycle?		
I listen to loud music while driving, have the air conditioning on cold, or I have the windows open.	Correlation Coefficient	-0.429
	Sig. (2-tailed)	P<0.005
	N	66

4.8 The Impact of Fatigue Management on the Advanced Life Support Providers' Health, Safety, and Clinical Management Performance

It was fundamental to this study to ascertain whether the informal fatigue management strategies were indeed effective in curbing the effects and symptoms associated with fatigue, which allowed the participants to improve their health, safety, and performance. The participants' input about their health, safety, and performance, was captured and evaluated, then cross-tabulated against their fatigue-management strategies.

When considering whether the participants' utilisation of fatigue management strategies reduced the effects and symptoms associated with fatigue, there was an indication that these strategies also improved their health. In their responses regarding their effective utilisation of fatigue-management strategies reducing the effects and symptoms associated with fatigue, 35/66 (53.0%) of the participants stated: 'occasionally when used'; and 16/66 (24.2%) stated 'always when used'. When these results were cross-tabulated, the results data revealed a significantly negative correlation (rho = -0.316) (Table 4.7), suggesting that the participants who utilised effective fatigue management strategies more, experienced less ill-health. This finding indicated the participants fatigue management strategies worked.

Table 4.7: Spearman's rho: Frequency of use of fatigue strategies and effect on health

When practising these fatigue-management strategies, how often do they reduce your symptoms of fatigue?		
How often do you have symptoms such as headaches, visual disturbances, temperature dysregulation, or sleepiness?	Correlation Coefficient	-0.316
	Sig. (2-tailed)	0.10
	N	66

In view of these results, significantly, 32/66 (48.5%) of the participants reported that their health was affected 'occasionally', which may have implications for clinical management performance and safety. Many of the participants indicated positive results (p=0.001) related to their utilisation of fatigue-management strategies in reducing their effects and symptoms associated with fatigue (Fisher-Freeman-Halton exact test, Table 4.8).

The participants were asked if they agreed that their fatigue management strategies improved their clinical management and safety, as well as their focus, motivation, and pro-activeness. In relation to clinical management and safety, this study found that 49/66 (74.2%) participants experienced improvement when utilising their fatigue-management strategies. The majority also reported positively with respect to their fatigue-management strategies improving focus, motivation, and pro-activeness, with 25/66 (37.9%) participants recording 'occasionally' and 20/66 (30.3%) reporting: 'always when used'. In addition, in total, 17 (25.8%) participants indicated that their fatigue-management strategies worked; either, 'on average once a shift' (11/66; 16.7%) or, 'on average once a shift cycle' (6/66; 9.1%).

There was a very significant association between fatigue-management strategies improving focus, motivation, and pro-activeness, and improving clinical management and safety (p<0.001). Those who agreed that fatigue management strategies improved focus, motivation,

and pro-activeness ‘always when used’ (20/66; 30.3%), were more likely to have agreed that fatigue-management strategies improved their clinical management and safety too (49/66; 74.2%). There were 4/66 (6.1%) participants who said ‘never’ to fatigue management strategies improving focus, motivation, and pro-activeness, who also agreed that fatigue management-strategies improved their clinical management and safety. This was an anomaly; but they were few in number.

Table 4.8: Fisher-Freeman-Halton Exact Test: Association between fatigue-management strategies improving clinical management and safety performance

	Value	Exact Sig. (2-sided)
Fisher-Freeman-Halton Exact Test	18.675	P= 0.001
No. of Valid Cases	66	

Figure 4.8 shows that a large proportion of participants (20/65; 30.8%) indicated that fatigue ‘never’ compromised their own or their patients’ safety at work. Equally, as seen in Figure 4.9, 20/65 (30.8%) participants reported that their ability to make clinical management decisions efficiently were ‘never’ affected by fatigue. From the data that was provided, cross-tabulations and Spearman’s rho revealed non-significant negative correlations (rho -0.168: Sig= -0.180) between the participants’ fatigue management strategies reducing the effects and symptoms associated with fatigue, and the chances of compromised provider or patient safety at work. The participants’ ability to make efficient clinical management decisions was similarly not impacted by their fatigue-management strategies (rho -0,219).

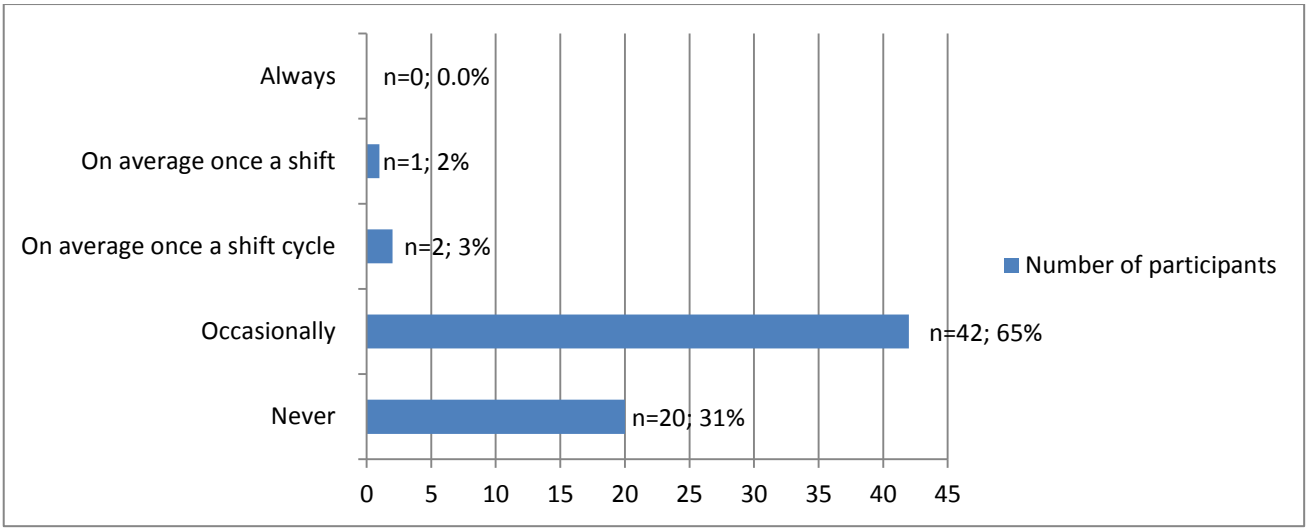

Figure 4.8: The frequency with which provider or patient safety was compromised at work

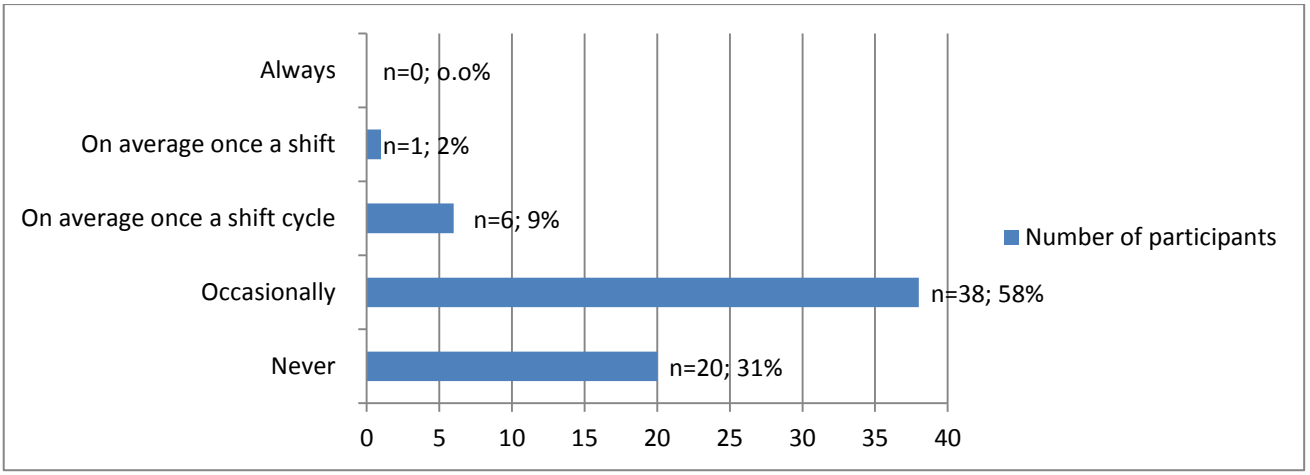

Figure 4.9: Participants' clinical management decisions affected by fatigue

4.9 Evaluation of the Advanced Life Support Providers' Successful Utilisation of their Fatigue-Management Strategies

The final section of the questionnaire sought to uncover definitive responses from the participants regarding the effectiveness of their fatigue-management strategies. In total, 65/66 (98.5%) participants recommended utilising fatigue-management strategies to limit or guard against the effects and symptoms associated with fatigue. Although more participants (38/65; 58.5%) concluded that their fatigue-mitigating and fatigue-proofing strategies were effective, fewer participants (27/65; 41.5%) did not believe their strategies to be effective.

The participants were asked whether they felt adequately rested and ready prior to the commencement of their shift, supporting successful implementation of fatigue-management strategies. Fifty-six of sixty-six (84.8%) participants responded positively to these questions, feeling adequately rested with frequencies ranging from ‘occasionally’ to ‘minimally in-between their shift cycles’ to ‘once in-between their shift cycle’ to ‘always’, indicating a significant positive correlation between the utilisation of fatigue-management strategies in reducing the effects and symptoms associated with fatigue, and a greater frequency of feeling adequately rested (rho = 0.299, p=0.015). Conversely, those who did not practise fatigue management strategies were less likely to feel adequately rested.

From the cross-tabulations, of those 16 participants that successfully ‘always’ practised their fatigue-management strategies, four of these participants ‘never’ found it increasingly difficult to maintain focus, motivation, or pro-activeness as their shift cycle progressed. What is more, in general, those participants’ whose responses reflected difficulty in maintaining focus, motivation, and pro-activeness as their shift progressed, were less likely to find that when they practised fatigue-management strategies, these strategies actually worked (rho = -0.256, p=0.038). However, when this association was stratified by a definitive ‘yes’ or ‘no’ answer to the question: ‘Do you feel that your fatigue-management strategies are successful?’, the association only held for those who had said ‘no’ (rho = -0.418, p= 0.030), (Table 4.9).

Table 4.9: Spearman's rho, stratified tabulation

The table, below, refers to participants' maintaining focus, motivation, and pro-activeness, compared to their frequency of use of successful fatigue-management strategies, stratified by a definitive 'yes' or 'no' question

Do you feel that your fatigue management strategies are successful?		When practising these fatigue-management strategies, how often do they reduce your symptoms of fatigue?	
Yes	Do you find maintaining focus, motivation, or productivity increasingly difficult as your shift cycle progresses?	Correlation Coefficient	-.035
		Sig. (2-tailed)	0.836
		N	38
No	Do you find maintaining focus, motivation, or productivity, increasingly difficult as your shift cycle progresses?	Correlation Coefficient	-.418
		Sig. (2-tailed)	0.03
		N	27

Based on the data provided by the participants on their personal experiences, in most areas where fatigue-mitigating and -proofing strategies were utilised and compared with the effects and symptoms associated with fatigue, they had found their fatigue-management strategies to be effective. However, some areas will require a different approach in order to limit and reduce the effects and symptoms associated with fatigue.

4.10 Summaries of the Data Analysis

The results demonstrated that the majority of the participants understood the concept of fatigue and the practise of fatigue management. Considering performance, the participants' length of shift did not appear to impact on clinical management errors in isolation. However, it is likely that ineffective off-duty rest and recovery may have compounded fatigue and resulted in clinical errors while on duty. Furthermore, participants who were least affected by fatigue, as a result of successful fatigue-management strategies, were less likely to find it difficult to process and retrieve information as their shift progressed. There was a significant association

between fatigue-management strategies improving focus, motivation, pro-activeness, and clinical management, while reducing symptoms of fatigue. There were a few participants who did not practise fatigue-management strategies, and they were less likely to feel rested.

Some participants understood the value of sleep hygiene and education and, accordingly, there was a significant association between knowledge of sleep hygiene and fatigue management. Regarding environmental stimuli, the data demonstrated that those who were more likely to be rested were less likely to make use of environmental stimuli or other factors, as a form of fatigue management which also had safety implications.

Significant areas of concern included that nearly half the participants experienced health symptoms and also, remarkably, only four participants were unable to identify the effects and symptoms associated with fatigue. Moreover, resting adequately between shifts or in their off-duty periods was difficult for the participants, and not always possible, which had lifestyle, health and fatigue amplification consequences. Considering the objectives of this study, it was important for the advanced life support providers to identify the symptoms of fatigue, in order to utilise fatigue management strategies to effectively guard against the development of fatigue.

More of those participants with more years' experience agreed that fatigue-management strategies improved their focus, motivation, and pro-activeness. Curiously, there was no association between being able to identify the symptoms of fatigue, and making use of caffeine products/energy drinks or quick snacks to relieve the effects of fatigue. There was no association between being able to recognise fatigue and taking naps/rest periods. However, participants did take naps/rest periods – probably for other reasons.

4.11 Summary

Initially, this chapter presented the demographic data, including years of operational experience and the lengths of shifts the participants were working. This chapter also presented their perceived effects and symptoms associated with fatigue, as well as the efforts the participants made to limit the fatigue they experienced. Findings suggested that some

informal strategies were more effective than others. The following chapter is an in-depth discussion of the study results and findings.

CHAPTER FIVE: DISCUSSION.

5.1 Introduction

The purpose of this study was to determine the use of informal fatigue management strategies by local advanced life support providers in order to safeguard themselves from operating in a fatigued state, beyond the point of safe practice. In order to address the research problem, the aim, and objectives, a quantitative study was undertaken, as detailed in Chapter Three. This included the administration of a questionnaire to local, operational advanced life support providers from the province of KwaZulu-Natal. This chapter will provide a detailed discussion of the study's findings and results.

5.2 The Demographic Profile of the Participants

At the time this survey was conducted, available facts and figures reflected that, in KwaZulu-Natal, the advanced life support providers were employed by provincial and private emergency medical care services and rendered operational services to both urban and rural residents throughout the province. Biographical data that comprised the participants' age, sex, and length of operational service (in years) was collected. This provided local biographical details which allowed comparison with other international regions where similar studies were conducted.

Of the participants, a third (n=22/66; 33.3%) were between 26 and 30 years of age. More than two thirds (n=45/66; 68.2%) of the participants were male. Cash *et al.'s* (2020) demographic data similarly reflected that most of their respondents were male; and those who held advanced life support qualifications were also older, with a mean age of 37.1 years (Cash *et al.*, 2020). In a different study, Ebata, Tatsuta and Tatemichi, (2017) enrolled 118 full-time female workers, and of these, 55 were shift-working females, and 40 were nursing staff. Their study attempted to investigate whether biomarkers could indeed be objective indicators of fatigue; and these participants were also older, with a mean age of 37.8 years (Ebata, Tatsuta & Tatemichi, 2017).

Regarding years' experience as an advanced life support provider, the largest group had 1-2 years' experience (n=17/63; 27.0%), followed closely by a group of participants with 5-10 years' experience (n=15/63; 23.8%). This was a useful indicator as it showed that a fair proportion of the respondents had several years of experience within the emergency medical care service and were also more mature. Similar findings were noted in a study by Bérastégui *et al.* (2020), where the median years of experience was six years (M=7.36, SD=6.58) (Bérastégui *et al.*, 2020). Three participants did not supply an answer to this question. The majority of participants were 26-30 years of age, male, and with 1-2 years' experience.

5.3 The Frequency and Severity of Effects and Symptoms associated with Fatigue Related to Performance, Safety, and Health

Participants reported their experiences of a total of 12 effects and symptoms associated with fatigue. These effects and symptoms were primarily categorised as health, safety, and performance issues. The utilisation of fatigue-management strategies implied that the users were capable of recognising the effects and symptoms associated with fatigue and were thus able to anticipate its effects on their health, safety, and performance.

The participants' responses were noted and cross-tabulated in order to evaluate if, indeed, an association existed between certain criteria. This would evidence the presence of fatigue, and thus demonstrate that fatigue-induced effects and symptoms related to shift work, health, safety, and performance validated the informal use of fatigue-management strategies.

5.3.1 The advanced life support providers' length of shift, clinical errors, and safety concerns:

Shift work is often lengthy and unpredictable in nature, and this leads to emergency medical care providers being subjected to irregular sleep patterns and circadian rhythm disruption, with the subsequent development of fatigue. Consequently, these providers were at increased risk due to the effects and symptoms associated with fatigue (Ogeil *et al.*, 2018). Shift work-induced fatigue has been found to have a detrimental effect on emergency medical care providers, leading to compromised patient safety, and errors in clinical judgement (Sofianopoulos *et al.*, 2011). Local advanced life support providers have a defined shift-working structure, necessary in order to provide a 24-hour round-the-clock lifesaving

emergency medical care service to the community. Participants were asked to provide input on their potential for making clinical management errors, and whether patient safety was compromised as a result of their shift length.

Ramey *et al.* (2019), suggested causative factors for the development of fatigue, which increased the risk of errors and included aspects of length of shift and shift structure (Ramey *et al.*, 2019). The above research concluded that the length of shift had an impact on the development of fatigue. From the data analysis, shift lengths were compared to outcomes of clinical management errors and compromised patient safety.

Locally, in contrast, the majority of the participants who responded indicated that they worked 12-hour shifts, fewer participants worked 24-hour shifts, and more than half the participants worked standby shifts. While all the participants that responded indicated that they were likely to make errors, their length of shift did not appear to have an impact on clinical management errors, and the frequency with which errors were made was not statistically significant. Considering the above data, those participants who worked 24-hour and standby shifts were on duty for longer periods, as opposed to their colleagues working 12-hour shifts; yet they were equally as likely, or unlikely, to make clinical management errors. Conversely, one study by Patterson *et al*. (2015), which involved testing a fatigue-reduction strategy, showed lower perceived fatigue-related symptoms and burnout after reducing the participants' length of shift from 24 to 12 hours. However this effect was short-term and these positive outcomes did not last longer than one year (Patterson *et al*., 2015) .

Interestingly the participants openly stated that they did make clinical errors. However, in an attempt to establish whether an association existed between these two variables, it was determined that their frequency of errors was not as a result of the length of shift. By contrast, nursing staff working shifts in a Japanese hospital indicated that they had made clinical errors and had experienced other administrative problems as a result of the length of shift (Kagamiyama & Yano, 2018). A possible reason for the lack of statistical significance for the clinical errors and effects on the performance of their specific roles may be due to the often unpredictable nature of emergency medical care service shift work, as described by Patterson *et al.* (2017) (Patterson *et al.*, 2017). Researchers have stated that shift workers in 'more predictable' industries do not experience the same levels of fatigue as those in the emergency

medical care industry which involves a more dynamic working environment (Dawson *et al.*, 2015). In the local environment, the advanced life support providers are managing greater numbers of emergency scenes; they are exposed to the clinical aspects of patient care, providing advanced interventions in growing communities; and they experience shifts that require a multifaceted approach to management and administrative tasks which contribute to the development of fatigue (Govender *et al.*, 2012; Stein *et al.*, 2016; Statistics South Africa, 2018). Bearing in mind the dynamic unpredictability of this shift work, the advanced life support provider may be dispatched to a variety of emergencies, which may range from the seemingly routine with unexpected complexities, to the critically ill, or injured, patient. Still, the advanced life support provider is expected to maintain a superior level of professionalism, while remaining susceptible to the effects and symptoms associated with fatigue, potentially resulting in clinical errors.

5.3.2 Clinical performance, information retrieval and processing:

Clinical information retrieval and critical thinking skills are a vital aspect of the advanced life support providers' skill set, as well as clinical patient management. Here, the questions explored fatigue-related effects and symptoms that the participants were experiencing, focussing on uncovering the participants' ability to retrieve clinical information, combined with their self-reported effects and symptoms associated with fatigue.

In a Japanese study conducted in 2018, among nursing staff, it was noted that an association between fatigue and insufficient sleep and stress developed due to the nursing staff working consecutive night shifts (Kagamiyama & Yano, 2018). Much like in this study, the nurses responded that they made clinical management errors, presenting as difficulties in recalling patient diagnostic parameters; performing procedures; medication administration problems and patient recording; and a lack of accuracy.

In keeping with the abovementioned study, the participants' ability to make clinical decisions efficiently was evaluated and compared to their ability to process information adequately (critical thinking) as their shift progressed. These two variables were cross-tabulated to assess whether there was a relationship between the two. It was revealed that, as in the Japanese study, a significant positive correlation existed between the participants' experience of fatigue and compromises in their ability to make clinical decisions; and they found it

increasingly difficult to retrieve and process information safely as their shift cycle progressed (rho = 0.480, p <0.001). The largest proportion of participants (n=38/65; 58.5%) felt that only 'occasionally' did fatigue effect their clinical management decision making. Moreover, the group of participants (n=32/66; 48.5%) who admitted that 'occasionally' it was increasingly difficult to retrieve information, were also affected by fatigue. Hence, those participants who were least affected by fatigue were less likely to find it difficult to process information as their shifts progressed. Also, 19 participants (n=19/66; 28.8%) felt that they 'never' experienced this difficulty. It also emerged that none of the participants (n=0/65; 0.0%) felt that fatigue 'always' affected their clinical decision making. The significance of these results illustrated that the participants had difficulties in retrieving information and critical thinking, resulting from the effects and symptoms associated with fatigue as their shift cycle progressed. This suggests that the participants did not experience the effects of fatigue in an acute sense, but rather chronically, signifying that the effects of fatigue compounded as their time on duty progressed. The advanced life support providers' exposure to factors that lead to fatigue can often be attributed to their shift conditions and the adequacy of their rest and recovery time when off duty (Ramey *et al.*, 2019).

5.3.3 The impact of fatigue on the advanced life support providers' health, regular lifestyle habits, inter-shift recovery, and behaviour:

As advanced life support providers are required to work shifts in order to render their services, as is inherent to shift work, they will be entitled to off-duty days. The participants were asked about fulfilling their plans, and their life-style habits, during their off-duty periods. During the participants' off-duty periods, they often engage in social activities, enjoy family time, and have hobbies. The participants' off-duty time is not only for recovery from shift work, but also for them to enjoy a fulfilling quality of life. Furthermore, participants were asked whether fatigue interfered with their personal health and physical energy, and if they were able to rest and recover adequately between their shifts. Noteworthy, sleep deficits, poor quality of sleep and compounding sleep debts were recognised as health problems by Patterson. P.D, *et al.*, (2012); Pirrallo *et al.*, (2012); and Härmä *et al.*, (2018) among shift working emergency medical providers, moreover they were unable to rest and recover adequately during their off-duty periods (Patterson *et al.*, 2012; Pirrallo *et al.*, 2012; Härmä *et al.*, 2018). It was also determined whether they were able to identify the effects and symptoms associated with fatigue, affecting their off-duty lives. The participants' input allowed for exploration of their own

lived experiences which gave insight into how fatigue affected their off-duty lifestyles and their rest and recovery time, as this would in due course affect their readiness to return to work.

International studies have explored some of the dynamics affecting inter-shift recovery. Participants reported that they could not effectively recover from fatigue between their shifts. Systematic reviews showed that more than half of these participants inadvertently started their next shift fatigued (Patterson. P.D, *et al*., 2015; Ramey *et al.*, 2019). What is more, as informed by a systematic review, 51.43% of firefighters were affected by poor off-duty sleep quality. One study on the global prevalence of sleep disorders among shift-working firefighters identified a number of causes, and types, of sleep disorders; as well as sleep satisfaction. Quality of sleep was noted as another aspect of inter-shift rest and recovery. It was shown that poor sleep quality could impact on a person's performance, health, and productivity, disrupting healthy social interactions and relationships (Khoshakhlagh *et al.*, 2023). Taking the findings of these studies into account, local shift-working, advanced life support providers are susceptible to poor quality of sleep and consequently also lack adequate inter-shift rest and recovery.

Locally, participants were unable to achieve adequate inter-shift rest and recovery; and it was shown that there was no association found between the participants feeling adequately recovered between their shifts and being able to identify symptoms of fatigue ($p=0.254$). Therefore, interestingly, a slight trend was noted that those who 'never' felt adequately recovered were unlikely to know the symptoms of fatigue, leaving the advanced life support provider, potentially, in a perpetual state of fatigue, and so starting their next shift in a fatigued state. Contrary to this study's findings, authors Patterson *et al*. (2015) proposed that more than half of their participants also reported on severe fatigue while at work (n=281, 55%), suggesting these participants understood the effects and symptoms associated with fatigue, although this was based on a larger sample size (Patterson. P.D, *et al*., 2015).

Curiously, four participants were unable to identify the effects and symptoms associated with fatigue. There were proportionately more of these participants in the group who indicated that they were 'always' not adequately rested and recovered. In addition, they also experienced a higher frequency of health-related symptoms. Nearly half (n=32/66; 48.5%) of all the participants experienced health symptoms and this may suggest inadequate rest and

recovery during their off-duty period. From the data, there was a significant association noted between these two variables (p = 0.035). Therefore, the importance of the participants' off-duty periods, when they can follow their regular lifestyle habits, enjoy family and social time, and exercise, allowing for adequate rest and recovery, may play a key role in reducing the effects and symptoms associated with fatigue. Noting the above, adequate inter-shift rest and recovery may promote a healthier lifestyle and optimises a state of readiness for duty.

Similar sentiments were expressed in studies conducted by Patterson *et al.* (2012), Pirrallo *et al.* (2012), Patterson *et al*. (2015), and Myers *et al.* (2018), who demonstrated that fatigue was experienced amongst shift-working pre-hospital emergency medical care providers, and that this fatigue was linked to decreased safety, reduced performance, and several chronic medical conditions (Patterson. P.D, *et al.*, 2012; Pirrallo *et al.*, 2012; Patterson, P.D, *et al*., 2015; Myers *et al.*, 2018). What is more, in an Australian study, 92% of the participants indicated they had experienced fatigue within the last six months (Sofianopoulos *et al.*, 2011). This highlighted the need for education and training to enable advanced life support providers to recognise the effects and symptoms associated with fatigue, which may be compromising their health.

Building on the above international research, locally, data analysis showed a slight positive correlation (rho = 0.253), that participants who experienced health symptoms also indicated that fatigue had interfered with their regular lifestyle habits including socialising, eating, and exercising. This was marginally statistically significant, and those participants who said they had experienced symptoms of ill- health, also agreed that fatigue had inhibited their regular lifestyle habits; and vice versa. These findings were congruent with conclusions drawn by MacQuarrie *et al.* (2018), stating the benefits of regular exercise and a healthy diet (MacQuarrie *et al.*, 2018). The authors demonstrated increased risks to acute and chronic fatigue, ultimately leading to chronic health problems. These authors found the advanced life support provider was often unable to maintain a healthy lifestyle as a result of the risks from shift-work fatigue (MacQuarrie *et al.*, 2018). Similar outcomes were seen locally, as the participants felt unable to maintain healthy lifestyle habits due to fatigue compounding over their off-duty and on-duty periods. This combination of the inability to adequately rest and recover; poor diet; lack of socialising, including family time; and insufficient exercise, resulted

in further elevated levels of acute and chronic fatigue with the associated health, safety, and performance complications.

Off-duty time is an important time for recovery, socialising and exercise. Participants also required a level of energy to be able to fulfil off duty-plans and maintain regular lifestyle habits. Regarding the participants off-duty recovery time, there was a significant association (p=0.025) between the majority of participants who felt that fatigue prevented them from achieving their off-duty plans, and those participants who were most likely to not recognise symptoms of fatigue. This is a significant finding, as the participants could not achieve their off-duty plans. This was particularly prevalent in the group who had experienced health symptoms. There were similar findings in an Australian study, where fatigue prevented the participants from keeping to healthy eating habits; being able to take advantage of regular physical activity; and participating in healthy social interactions, including family time (Ferguson, Neall & Dorrian, 2013). No correlation was found between being able to identify the symptoms of fatigue, and lacking the physical energy to achieve off-duty plans, and maintaining regular lifestyle habits (p=0.505). In contrast to the above study, locally, many of the participants (n=32/66; 48.5%) felt that they 'occasionally' lacked physical energy, although they did not associate this with fatigue.

Furthermore, the participants offered their insights into specific behavioural effects related to fatigue. Many of the participants, (n= 30/66; 45.5%) reported that feelings of empathy, frustration, irritability, and hastiness were experienced 'occasionally' and more than half the participants (n= 37/66; 56.1%) felt they could have done more for their patients. These two variables were measured against each other. The data provided did not suggest an association between participant behaviour and patient interaction (Rho = 0.136, p=0.277) being impacted by fatigue. Generally the results demonstrated that the participants felt comfortable with their behaviour and their patient interaction, and that these behavioural aspects were not affected by their levels of fatigue.

Considering the data that was evaluated, significant findings suggest that the participants were, indeed, experiencing fatigue; and this had affected both, their on- and off-duty health, safety, and performance. These results showed that participants felt they were prevented from achieving their off-duty plans; and they also experienced symptoms of ill-health, while,

on occasion, not recognising the symptoms of fatigue. What is more, participants felt that fatigue affected their clinical decision making related to performance, and also their safety, as their shift progressed.

5.4 Evaluations of the Efficacy of Informal Fatigue Management Strategies

While some findings related to the first objective were significant, local advanced life support providers were, indeed, experiencing fatigue, and this had an effect on their health, safety, and performance. However, there is limited research involving emergency medical care providers' use of fatigue management strategies, the efficacy thereof, and their perceived outcomes related to health, safety and performance. This section of the discussion explores the participants' self-reported effects and symptoms experienced as a result of fatigue. The next section evaluated the participants' ability to manage their fatigue by utilising specific strategies. Research has suggested that, for the participants to effectively manage their fatigue-related risks, effects, and symptoms, they should incorporate fatigue proofing- and mitigating-strategies that complement an approach to safe fatigue reduction (Dawson *et al.*, 2017). Similarly, Barger *et al.*, (2018), in discussing fatigue management, highlighted two fundamental approaches, namely fatigue proofing and fatigue mitigation, as discussed in Chapter Two (Barger *et al.*, 2018). The informal fatigue-management strategies that were utilised by the participants fell into either the fatigue proofing or the fatigue mitigation categories.

Fatigue proofing is a form of sleep/recovery and includes education to lower the incidence of fatigue. Fatigue mitigation is the strategic use of techniques to reduce the effects and symptoms associated with fatigue. Fatigue-proofing strategies aim to reduce the risks of fatigue, and include techniques to reduce sleepiness by incorporating sufficient rest, diet, and exercise. Fatigue-mitigation strategies include napping, caffeine intake, and environmental considerations, amongst other strategies (Barger *et al.*, 2018; Bérastégui *et al.*, 2018).

Ultimately, the effective reduction of the effects and symptoms associated with fatigue implies that the participants are able to assess their own levels of impaired alertness, and are aware of the negative consequences of fatigue, on their health, safety, and performance; and are thus able to act on these perceptions.

5.4.1 The participants' years of experience related to their ability to limit the effects and symptoms associated with fatigue:

Rationally, as the participants had more years of experience, they should be able to identify and limit the effects and symptoms associated with fatigue before they become apparent. This notion relies on the advanced life support provider gaining invaluable experience working shifts over the years and may, as a result, recognise feelings of fatigue. They may even have attempted to incorporate various countermeasures to maintain a level of efficiency and safety over the course of their experience.

The participants expressed their years' of experience and accordingly the researcher sought to uncover whether; indeed, there was an association between years of experience and the ability to manage fatigue. Responses from local participants showed that there was a weak positive correlation, which was statistically significant (rho= 0.297), between the participants' years' of experience and an acknowledgement that their fatigue management strategies improved their focus, motivation, and pro-activeness (performance). Therefore, the greater the participants' years of experience, the more likely they were to agree that their fatigue management strategies were successful, and vice versa. This confirmed the sentiment that, as the participants amassed years of experience, they were able to identify and limit the effects and symptoms associated with fatigue before they became apparent. Contrary to the above, however, Cash *et al.* (2020) found that the older and more experienced subgroup in their study were more susceptible to stress, sleep disorders and fatigue, and suggested that interventions should be targeted at these subgroups (Cash *et al.*, 2020).

5.4.2 Fatigue management strategies that were utilised by the advanced life support providers:

In the contemporary setting, fatigue management strategies in the emergency medical care service would be based on informal strategies, as used by the advanced life support providers, which have been found to be successful for them, personally. Participants had the opportunity to report on specific fatigue-mitigating and -proofing strategies pertaining to their ability to manage their fatigue. Fatigue mitigating strategies that were utilised included, but were not limited to, task-loading; delegation of duties and tasks to other colleagues, or to be completed later in hospital; the participants' use of reference materials; focusing intensely on

tasks; self-regulation, limiting errors and risks; utilising caffeine products; and taking naps/rest periods while on shift.

These above-mentioned strategies may have enabled the advanced life support provider to adapt to, and limit, the effects and symptoms associated with fatigue while on duty. This would also allow for effective performance and ensure both, theirs' and their patients', safety while on shift. 'Task-related strategies' and 'behaviour-based strategies' were discussed in a focus group for shift-working defence aviation specialists for reducing fatigue-related risk to themselves and their colleagues. The author found these strategies were utilised frequently and consistently by most of the participants in an effort to mitigate against the risks of fatigue while on shift. What is noteworthy is that these strategies, considered above, were utilised most frequently by the participants while experiencing fatigue during their shift. Therefore, these participants were capable of identifying the effects and symptoms associated with fatigue and acted on this with intuitive self-developed informal strategies (Dawson *et al.*, 2017).

Considering the above study on fatigue mitigation strategies as practiced within a high risk shift working industry, local participants practiced similar fatigue-mitigating strategies. While the advanced life support provider is required to render emergency medical care to the ill and injured patient at the scene of an emergency, teamwork is essential in reaching their objectives. As the advanced life support provider works alongside colleagues, not all procedures are required to be done by the advanced life support provider; some procedures and treatments may be delayed, omitted or delegated. Nearly half the participants (n=32/66, 48.5%), would delay or omit certain procedures or treatment regimens due to feeling fatigued, possibly to reduce the risk of errors, or harming their patients, and so responded as 'always' delegated responsibility or secondary tasks to their colleagues; while 10/66 (15.2%) would 'always' leave less important/urgent tasks to be later managed in hospital. A study conducted in Canada consisting of 11 physicians, participated in a focus group to discuss their fatigue management strategies. These physicians noted that they would defer or prioritize tasks while fatigued thereby reserving their cognitive energy for patient care at a time when concentration was difficult. Additional strategies also included, verbalising for assistance, writing down details, and double checking procedures and medications. (Henrich *et al.*, 2016).

In an effort to limit errors and to self-regulate, participants verbalised their actions, either to themselves or to their colleagues. They also verbalised that they were experiencing a level of tiredness. The majority of the participants recorded that they 'always' double-checked the medication (drug) choices and doses they would be administering to their patients. Additionally, a large number of participants (n=41/66; 62.1%) indicated they 'always' completed their administrative tasks timeously in an effort to avoid these tasks from accumulating, giving testament to their acknowledgement of the importance of these tasks which form part of their duties as an operational advanced life support provider.

When taking into account error monitoring and avoiding mistakes, advanced life support providers would often refer to manuals and procedural patient-treatment algorithms (patient treatment flow charts) to ensure accurate patient care, which both minimised cognitive load and ensured accuracy, while managing dynamic high acuity emergency scenes. Nine participants stated that they 'never' made use of these techniques, while twelve participants 'always' made use of these techniques, revealing a narrow range between those who made use of them, and those who did not. Reflecting local advanced life support provider use of fatigue mitigating strategies, it was found that similar fatigue management strategies were performed by Canadian intensive care unit physicians. Notably, these physicians as with local advanced life support providers wanted to ensure mental endurance, decreased cognitive load, and prevent patient harm. (Henrich *et al.*, 2016)

As the participants' shift cycles progressed, they were subjected to the effects and symptoms of fatigue. Thus to minimise errors, ensuring optimal patient care and during the performance of administrative tasks at their base, a percentage of the advanced life support providers would often focus intensely, combined with the use of manuals and patient treatment flow charts, rather than multitasking, which would reduce their concentration and focus on a particular task. Over half the participants (n= 37/66; 56.1%) reported focusing on one task at a time, rather than multi-tasking 'occasionally'. One can, therefore, infer from the data that most do, indeed, focus intensely on a single task in order to achieve optimal performance and a safe outcome as a fatigue-mitigating strategy. Furthermore, it appeared that there was no association between the participants focusing intensely on tasks (n=46/66; 69.7%), and those making use of manuals and algorithms (patient treatment flow charts), (n=12/66; 18.2%), (p=0.512). The response from the participants in this regard may be explained by the fact

that, irrespective of fatigue, advanced life support providers frequently make use of manuals and algorithms and consult with colleagues in the interest of gold standard emergency medical care.

Other well-known fatigue-mitigating strategies were explored and it was determined whether associations existed between these practices: consumption of caffeine products; a quick snack; or opportunistic napping/rest periods, in order to re-energise to mitigate the effects and symptoms associated with fatigue. Despite regular statements in the literature, suggesting the use of caffeine-based products, a study by Temple *et al.* (2018) showed inconsistent randomization in some of the reviewed literature; inconsistent use of caffeine in other studies; multiple, differing doses; and inconsistencies regarding when they were consumed (Temple *et al.*, 2018). These variables in the use of caffeine products skewed the data; but overall, only a little evidence was provided for the use of caffeine. Similarly, Satterfield and van Dongen (2013) found little evidence findings, citing in particular the differences in human physiology and caffeine uptake, efficacy, and half-life (Satterfield & van Dongen, 2013). However, Patterson *et al.* (2018) and Temple *et al.*(2018) subsequently recommended caffeine intake during shift work as a technique to mitigate fatigue (Patterson *et al.*, 2018; Temple *et al.*, 2018). Contrary to the above authors' findings, it appears that those in this study who knew the effects and symptoms associated with fatigue were about equally likely, or unlikely, to make use of caffeine products or a quick snack; while those who did not know about them were most likely to make use of food or drink.

Perplexingly, a considerable number of the participants (n=19/66; 28.8%) reported making use of caffeine or a light snack 'multiple times per shift'; while the second-largest group consumed caffeine products or a light snack 'occasionally' and 'on average once a shift' (n=15/66; 22.7%) to relieve the effects and symptoms associated with fatigue. Notably, there was no association between being able to identify the effects and symptoms associated with fatigue, and making use of caffeine products/energy drinks or light snacks to relieve these effects and symptoms (p=0.416). It can thus be proposed, based on the data, that in the participants' experience, their consumption of caffeine/energy drinks or a light snack was not a conscious strategy to mitigate the effects and symptoms associated with fatigue, but rather refreshment.

What is more, during their on duty shift, in order to re-energise, most participants felt it necessary to take opportunistic naps/rest periods and reported their frequency as ‘occasionally’ (n=27/65; 41.5%); and those who reported using this mitigation strategy only ‘once per shift’ were 23.1% (n=15/65) of the total. When correlations were sought between identifying the effects and symptoms associated with fatigue, and the participants taking opportunistic naps/rest periods to re-energise, there was no association found between being able to identify the symptoms of fatigue, and taking naps/rest periods (p=0.865). However, in participants not able to identify the effects and symptoms associated with fatigue, there was a slight trend towards being less likely to take naps/rest periods. From the data, it may be reasonable to postulate that their naps/rest periods were, indeed, an attempt at mitigating the effects and symptoms linked with fatigue, given the associations embedded within the data.

In the same way, a study conducted in Japan on scheduled napping/rest periods among emergency medical care service personnel, concluded that self-reported results showed there was no perceived or marked improvement in reaction time, or reduction in overall fatigue/sleepiness (Takeyama *et al.*, 2009). However, other international studies have explored some of the factors affecting napping/rest periods to re-energise: Ruggiero and Redeker (2014) found that short napping periods during a shift may reduce sleepiness and fatigue, improving performance and cognitive ability, and reducing errors (Ruggiero & Redeker, 2014). However, considering the effective duration of napping/rest periods that would need to be undertaken by advanced life support providers, researchers were unable to determine which scheduling strategy would optimise this technique (Martin-Gill *et al.*, 2018). This was in keeping with the Martin-Gill *et al.* (2018) and Patterson *et al.* (2018) studies, which indicated that napping and rest periods may be detrimental (weak evidence) as the duration of the napping/rest periods varied in different studies. It was also noted that napping for 10-20 minutes may improve alertness; but longer napping periods have been known to lead to significant sleep inertia, amplifying fatigue and safety problems (Martin-Gill *et al.*, 2018; Patterson *et al.*, 2018). Martin-Gill *et al.*, (2018;) and Patterson, Higgins, *et al.*, (2018) concluded that the concept and duration of napping/rest periods requires additional research (Martin-Gill *et al.*, 2018; Patterson, Higgins, *et al.*, 2018).

Fatigue-proofing strategies play an essential role when preparing for shift work that may often be lengthy and unpredictable. The participants utilised strategies that included sleep

hygiene/education and resting adequately between their shifts. Adequate rest and recovery when off duty are central to the health, safety and performance of the advanced life support providers. Thus, the researcher determined whether the participants were aware of sleep hygiene/education, and the frequency with which the participants expressed feeling adequately rested, based on their fatigue-management strategies. This was measured against fatigue impacting their off-duty plans and regular lifestyle habits. Moreover the researcher considered whether the participants were avoiding heavy meals prior to the start of their shift; their utilisation of environmental stimuli; and exercising regularly. In addition, the researcher attempted to establish whether the participants were actually utilising these strategies effectively.

Shift work impairs the human circadian rhythm, which impacts on internal biological day-time cognizance and inadequate biological night-time sleepiness. The predominant health problem reported by shift workers was insufficient or disturbed sleep. It has been reported that at least three-quarters of the shift-working population have been affected by this problem (Akerstedt, 2009). As discussed previously, shift work requires on-duty wakefulness and alertness during both the day and at night. This further promotes the concept of education and training in sleep hygiene.

In light of education and training in sleep hygiene and fatigue, which had been further reinforced in a systematic review by Ogeil *et al.* (2018), data highlighted the participants' attendance at fatigue education sessions. The attendees subsequently reported fewer injuries and disabilities at work, with positive outcomes (Ogeil *et al.*, 2018). This local study supported the above-authors' conclusion, and noted a significant association between knowledge of sleep hygiene and fatigue proofing. Of those with adequate knowledge of sleep hygiene, 30% were 'always' rested, whilst of those without adequate knowledge, only 2.8% were adequately rested ($p=0.011$). On the other hand, contrasting with this study's results, different findings were obtained from Bérastégui *et al.'s* study (2018). They noted that the majority of emergency physicians in their study were not well educated on sleep hygiene and this was evident in the limited success of their self-reported perceived fatigue management strategies (Bérastégui *et al.*, 2018).

The knowledge or training on sleep hygiene that the local participants appeared to have, have proven to be an effective safeguard against the effects and symptoms associated with fatigue. They felt that their fatigue proofing was as a result of adequate sleep hygiene knowledge and this allowed the participants to feel more rested, which naturally promoted health and safety, and improved their performance.

Additional fatigue-proofing strategies that were utilised by the participants included their preparations prior to the commencement of their shift. Such preparations involved getting adequate rest and the avoidance of heavy meals prior to starting shift work. Participants reflected on getting appropriate rest in a favourable environment prior to the start of their shift and the results demonstrated that this was done mostly on an ‘’occasional’’ basis rather than a necessary routine. Arguably, most participants felt it necessary, in some way, to be rested, inferring their anticipation of the lengthy and unpredictable nature of their shift work and the requirements of their role as advanced life support providers. Additionally many of the participants (n=25/65; 38.5%) felt that avoiding a heavy meal prior to the commencement of their shift would reduce the likelihood of developing fatigue. Similar results were seen in an emergency medical service study conducted by Mansouri *et al.*, (2021) in which participants attempted to regulate their meal intake prior to and during shift work. However, this resulted in, un-balanced high caloric meal and fluid intake with potentially compounding health consequences, noting differing levels of activity and intake for day shifts versus night shifts. More so, the researcher found that this also had implications for the physical activities of the providers (Mansouri *et al.*, 2021).

Emergency services do not mandate physical fitness requirements as such personal physical fitness or activity is maintained by the emergency medical service provider (Mansouri *et al.*, 2021). This study also found that many of the participants specified that they exercised only ‘occasionally’, although a smaller, but sizable, group indicated that they ‘always’ exercised. Building on these results, epidemiological studies have shown that physical activity during off-duty time reduces the risk of experiencing fatigue (Bérastégui *et al.*, 2018). Although the benefits of regular exercise and a healthy diet are well established, advanced life support providers are often unable to maintain healthy lifestyle habits. Research has alluded to several barriers to maintaining a healthy lifestyle, and in particular a level of fitness, among the personnel in the Australian emergency medical care industry (MacQuarrie *et al.*, 2018). A

level of fitness and diet are two aspects of a healthy lifestyle and considering this, fatigue-proofing strategies such as regular exercise may reduce the likelihood of developing fatigue and chronic health complications. The authors suggested that, in the long term, shift work-related fatigue, lack of fitness, and the high rates of injury that were incurred during shift periods may contribute to poorer health outcomes in advanced life support providers. Therefore, adequate off-duty rest and recovery periods, and healthy, regular lifestyle habits that limit the development of fatigue while on shift are important.

Environmental stimuli often play a role in the proofing against fatigue. With this in mind, the researcher wanted to establish the frequency and effectiveness of the participants' use of environmental stimuli/factors. When the participants considered environmental stimuli as a fatigue proofing strategy, reference was made to external stimuli. This typically included being outside for fresh air, or to smoke a tobacco product; splashing their faces with cold water; driving either with the air-conditioning set to 'cold' or having the windows open; or listening to loud music all in an effort to proof against the development of fatigue. Studies have shown that the utilisation of these environmental stimuli is not limited to local advanced life support providers. Shift workers in other high-risk industries such as aviation, emergency physicians and nurses, and fire/rescue services practise these strategies too (Bérastégui *et al.*, 2020). Applying these strategies while on duty may indicate that the participants are attempting to manage the effects and symptoms associated with fatigue, when they may not have been adequately rested prior to the commencement of their shift. Moreover, sleep debt is recognised as an accumulation of periods of poor or inadequate sleep or rest prior to shift, or while off-duty, and is seen to compound over the course of the shift workers' successive shifts. Consequently, many start their next shift in an already fatigued or sleep-deprived state (Ruggiero & Redeker, 2014).

Locally, many participants chose to go outside for fresh air or a tobacco product 'multiple times per shift'. Nearly half the participants indicated that they listened to loud music while driving, had the air conditioning set to 'cold', or had the windows open, as a strategy to limit the effects and symptoms associated with fatigue. While this practice may prove dangerous and result in vehicle collisions, it is often deemed necessary by the provider to manage the effects and symptoms associated with fatigue (Patterson *et al.*, 2012). Added to this, driver distraction and fatigue are known to be a major determinant to road traffic collisions the world

over, with fatigue often exacerbating distraction (Soares and Sara Ferreira, 2020). These fatigue-proofing strategies were evaluated against the participants' feeling adequately rested and ready prior to the commencement of their shifts. The results showed a negative correlation which was statistically significant (rho = -0.429, $p<0.001$), revealing that those who were more likely to be adequately rested were less likely to listen to loud music or have air conditioning set to 'cold', or their windows open while driving. It can thus be said that those participants who practised fatigue proofing by being adequately rested did not require the additional environmental stimuli to maintain a level of safety and performance efficiency while on shift. Furthermore as a result of effective fatigue proofing, as in the above example, the advanced life support providers are able to further ensure their safety while driving to the scene of an emergency by limiting distracting 'loud' environmental stimuli.

Fatigue proofing, training, and education strategies, such as getting adequate rest in a favourable environment prior to shift work; avoiding heavy meals prior to the commencement of shift work; regular exercise; and healthy lifestyle habits, are paramount in obtaining a level of fatigue proofing and reducing the likelihood of developing fatigue. However, in systematic reviews, conclusions were drawn, and consensus reached, that further studies involving healthcare practitioners and emergency medical care service providers were needed to investigate the effectiveness of these fatigue management strategies, which would safeguard better health, safety for the providers and their patients, and promote optimal performance (Ramey *et al.*, 2019).

5.4.3 The impact of fatigue management on the advanced life support providers' health, safety, and clinical management performance:

Shift work requires day- and night-duty and, as a result of this, employees are subjected to inadequate sleep and insufficient rest, and the resultant irregular circadian rhythms. This has also been linked to increased risk related to performance, health, and emergency care provider and patient safety (Pirrallo *et al.*, 2012). It was central to this study to ascertain whether the informal fatigue management strategies were indeed effective in curbing the effects and symptoms associated with fatigue, so that the participants were able to perform safely and improve their health, safety, and performance. The participants' input was cross-tabulated against their fatigue management strategy ability to reduce the effects and symptoms associated with fatigue.

Indeed, the participants' regular lifestyle habits, such as diet, exercise, socialising, and ensuring adequate rest prior to shift work, contributed to good health, which was influenced by their level and frequency of fatigue. As such, their fatigue management strategies needed to be successful in order to maintain a level of good health; yet almost half of the participants in this study admitted to 'occasionally' experiencing symptoms of ill-health. Similarly, Puttonen, Härmä and Hublin (2010), Patterson *et al.* (2012), and Ramey *et al.* (2019) described both transient and chronic health effects and symptoms, which were associated with fatigue, in emergency medical care services personnel. What is more, the authors also highlighted that health symptoms have serious consequences for provider and patient safety and performance in their work place (Puttonen, Härmä & Hublin, 2010; Patterson *et al.*, 2012; Ramey *et al.*, 2019). Locally, the data showed that advanced life support providers felt their fatigue management strategies worked and reduced their health-related effects and symptoms associated with fatigue. Given this, the greater the frequency with which the participants practised their fatigue management strategies, the less likely they were to be affected by symptoms of ill-health. This statistical outcome was significantly negatively correlated (rho = -0.316, p=0.01), and these findings supported the researcher's hypothesis related to the health of the advanced life support providers, in that when fatigue management strategies were utilised, they were effective.

As a comparison, in an international study conducted at Liège University Hospital Centre in Belgium, visual disturbances and a lack of focus were recognized as health and performance problems, among others associated with fatigue (Bérastégui *et al.*, 2018). Similarly, in this study, these symptoms were also frequently experienced by local participants, and they agreed that their fatigue management strategies improved their performance (focus, motivation, and pro-activeness). Thirty percent of the participants indicated their fatigue management strategies were 'always' effective when utilised. Furthermore, results demonstrated that those participants experiencing fatigue, and who agreed that their fatigue-management strategies improved their focus, motivation, and pro-activeness, were more likely to agree that their clinical management and safety improved. This outcome demonstrated a very significant association between the participants' fatigue-management strategies improving their focus, motivation, and pro-activeness, and also improving their clinical management and safety (p=0.001). Bérastégui *et al.* (2018) also concluded, in line

with this study, that there is a significant association between the participants' reaction/focus time and the frequency of use of their fatigue reduction strategies ($F = 4.91$, $p = 0.03$) (Bérastégui *et al.*, 2018). This highlighted the efficacy of the participants' fatigue-reduction strategies which, when used more frequently, revealed greater improvement in reaction time and focus, suggesting a greater level of performance and safety.

Regarding additional performance parameters, advanced life support providers manage emergency scenes with actual real-time situational awareness, ensuring the safety for themselves, their colleagues, and their patients. Additionally they are required to make effective decisions regarding patient treatment and overall emergency scene progression. When shift workers from other high-risk industries attempted to function on too little sleep, or poor quality sleep, without being adequately rested, this resulted in significant workplace accidents, which were, directly and indirectly, linked to the effects and symptoms associated with fatigue. Similar fatigue-related risks have been noted across several studies, and include under-estimation of risk; decreased situational awareness; reduced reaction times; and health problems (Goodson. B, 2023).

Another study found that fatigue and sleep deprivation were significant contributors to a lack of situational alertness and inconsistent decision making (Whitney *et al.*, 2017). Comparable with these studies, the majority of local participants felt that fatigue affected their ability to make clinical management decisions efficiently, suggesting that their fatigue-management strategies mostly worked in these instances. These variables also showed small, non-significant negative correlations.

Participants practised fatigue-proofing and -mitigation strategies in order to deliver the safe and robust clinical management modalities, crucial to sound patient treatment. In a study by Patterson *et al*. (2015), the majority (n= 458; 89.6%) of the respondents reported that they had perceived safety risks to themselves and their patients, due to fatigue, and this was cause for serious concern (Patterson *et al*., 2015). Conversely on the topic of safety, in this study, more than half of the participants did not perceive that fatigue affected their patients', or their own safety at work and fewer perceived that fatigue 'never' affected their, or their patients' safety, suggesting that a greater number of the participants 'occasionally' felt that their fatigue-management strategies were effective when it came to safety. Thus, by

comparing these variables, the results demonstrated a trend towards a negative correlation. Similarly nearly three-quarters of the participants (n=49/66; 74.2%) responded positively and definitively, when asked whether their fatigue-management strategies improved their clinical management and safety. Those participants who felt adequately rested (n=25/66; 37.9%), felt that their fatigue management strategies worked, and they were also more likely to say that there was an improvement in their clinical management and safety, for themselves and their patients. This association was not statistically significant.

Perplexingly, four participants (6.1%) said that their fatigue management strategies 'never' improved their focus, motivation or pro-activeness, but agreed that their fatigue management strategies improved their clinical management and safety, which is an anomaly; but they were few in number. It is possible that these participants did not understand the line of questioning in this phase of the survey.

International research has linked the impact of fatigue on the advanced life support providers' health, safety, and performance. Local relevance has been shown, with the majority of the participants reporting effects and symptoms associated with fatigue. Participants felt their fatigue management strategies were mostly successful, although not all associations that were sought were statistically significant.

5.4.4 Evaluation of the effectiveness of the advanced life support providers' fatigue management strategies:

Performance measurements are a key element in the implementation and evaluation of evidence-based practices when considering the efficacy of fatigue-management strategies (Ferguson, Neall & Dorrian, 2013). The above sections discussed the utilisation of fatigue-management strategies by local advanced life support providers. This final section explores the participants' perceptions of the effectiveness of their fatigue-management strategies. These strategies were assessed by evaluating the participants personally experienced perceptions.

When interviewing defence aviation personnel on their informal utilisation of fatigue countermeasures, Dawson *et al.* (2017) found that these participants successfully utilised fatigue-proofing and fatigue-mitigating strategies to overcome the effects, symptoms and risks

associated with fatigue (Dawson *et al.*, 2017). These participants, like the majority of the local participants, were aware of the potential benefits of managing their fatigue and reducing their risks. In this study, in the interests of health, safe practice and performance, local participants were asked whether they felt that their fatigue management strategies worked when they practised them.

Overall, the findings highlighted that participants struggled to fulfil their off-duty plans owing to feeling fatigued, and this was particularly prevalent in the group that had experienced symptoms of ill-health. Consequently, this prevented the participants from following healthy eating habits; being able to take advantage of regular physical activity; and participating in healthy social and family interactions. Noteworthy areas of concern included that nearly half of all the participants experienced symptoms of ill-health as a result of fatigue.

Local results further identified participants who felt ‘occasionally’ adequately rested prior to the commencement of their shifts when they ‘always’ practised fatigue-management strategies. The data also revealed that advanced life support providers who practised fatigue management strategies felt they worked and reduced their health-related effects and symptoms associated with fatigue. Accordingly there was a significant, positive correlation between being adequately rested prior to the commencement of their shift and utilising fatigue-management strategies (rho = 0.299, p=0.015). In conclusion, those who did not practise fatigue management strategies were less likely to feel rested; and vice versa. Not too dissimilar to this local study, in another study, emergency department physicians found that when their fatigue-protective strategies were actively utilised, self-management improved and this was associated with decreased reaction time (F = 8.02, p = 0.01) and improved performance (Bérastégui *et al.*, 2018). Therefore, internationally and locally the participants valued fatigue proofing, which allowed them to be adequately rested for lengthy and unpredictable shift work.

Considering the participants’ responses, those who indicated they experienced fatigue ‘on average once a shift cycle’ found it increasingly difficult to retrieve and process information safely. However, when they practised fatigue-management strategies, it reduced the effects and symptoms associated with fatigue at least ‘once a shift cycle’ (n=6/66; 9.1%). In general, those who found it increasingly difficult to maintain focus, motivation and pro-activeness, also

practised fatigue-management strategies, albeit less frequently, and thus were less likely to find that their strategies had worked (rho = -0.256, p=0.038). It was possible that this may have been as a result of utilising an ineffective strategy, or using it less frequently. However, when the above associations were split by the participants' perception of who did, and who did not, feel that their fatigue management strategies were effective, this association only persisted for those who said 'no' to feeling that their fatigue management strategies were successful. (rho = -0.418, p= 0.030).

When considering the above data and the evaluation of the efficacy and frequency of use of fatigue management strategies, in total 65/66 (98.5%) of the participants recommended utilising fatigue-management strategies to limit or guard against the effects and symptoms associated with fatigue. Although 38/65 (58.5%) participants concluded that their fatigue-mitigating and -proofing management strategies were effective, a lower number of participants (n=27/65; 41.5%) did not believe their strategies to be effective. Considering the required high level of professionalism, participants understood the extraordinary levels of performance and responsibility required of them, and the value of informal fatigue-management strategies.

5.5 Limitations of the Study

The limitations of the study included the following:

1. This local sample consisted of 66 operational, advanced life support providers who completed the survey questionnaire from the province of KwaZulu-Natal. If researching the national population, this would increase the sample size, and the results may be more focused and could, in some instances, differ from this study.

   The total accessible target population who met the inclusion and exclusion criteria numbered 86. Respondents who met the inclusion criteria to answer the online questionnaires totalled 66 participants. Considering the lower number of participating respondents, the statistical significance and the probability values in this study indicated specific cause, and how certain the researcher was that correlations between two or more variables either existed, or did not exist, and were not as a result of chance. Where statistical significance existed, this highlighted the high probability of the correlation between independent and dependant variables where these variables were closely associated.

2. Potential respondents may have lacked the interest to respond. Some (20 were noted from the survey) dropped out before completion; and on-line surveys typically produce low response rates. For this reason, the study might not be generalised to the overall population. To overcome this limitation, the researcher contacted both personal acquaintances and colleagues and with permission they distributed the survey link further.
3. Some participants may have felt disinclined to participate, or to complete the survey, as acknowledging fatigue has negative connotations in terms of job performance and individual status. Some participants may have felt the need to answer certain questions put to them in a particular manner that, in their view, reflected good practice. However, this may not have been their actual view on the topic or question posed.
4. Although the data was collected from both urban and rural areas, time constraints and distribution logistics (internet connectivity and access) meant that a number of questionnaires either did not reach their intended destination or were not completed. E-mail addresses, contact numbers, and social links may have been out-dated or even unverified. This, potentially, inhibited access to the survey. To overcome this, the researcher made use of other electronic platform lists and personal acquaintances and colleagues to reach additional participants. Moreover, the researcher frequently sent courtesy emails and electronic contact reminders. There was limited data that provided up to date, accurate communication pathways; and no data was available that would suggest the ratio of advanced life support providers that met the inclusion criteria, to those that did not meet the inclusion criteria.
5. Information obtained from websites, for example, the Health Professions Council of South Africa, and other informational sources, did not differentiate between advanced life support providers that met the inclusion criteria, and those who did not. Websites often did not provide up-to-date figures, which led to incorrect numbers for advanced life support providers who were registered and employed locally. During this period this study was conducted, potential participants relocated, resigned, or emigrated. This posed additional challenges for the researcher to remain current with the number of advanced life support providers, and to promote interest among the potential respondents, by frequently dispatching reminder communications and snowball sampling.
6. The study was conducted over a specific time period and thus the cross-sectional design of this study represented the fixed time-point at the time of data collection. Given that

fatigue is dynamic and changes with time, provider experience, and environmental conditions, a survey conducted at a different point in time may yield different outcomes.

7. The interpretation of some of the descriptions used in the survey questionnaire, answers using the Likert-type scale, as well as specific questions, may have been misunderstood by participants (example ‘occasionally’). Some participants may not have been English first language speakers. This limitation may have affected the validity and reliability of certain questions.

5.6 Summary

Fatigue-proofing and fatigue-mitigating strategies are changing the way shift work is being completed, to a more bio-efficient way, in terms of individual safeguarding and self-regulation. The results from this study demonstrated that the advanced life support providers were generally confident in their intuitively and naturally developed, informal fatigue management strategies, by recognising and responding to the effects and symptoms associated with fatigue. The participants’ utilisation of both fatigue-proofing and fatigue- mitigation strategies was explored and the results of the efficacy and frequency of these strategies were discussed. However, locally, safe and effective strategies for fatigue mitigation and fatigue proofing have not, as yet, been formalised. The following and final chapter concludes the study and contains the researcher’s recommendations in respect of fatigue management.

CHAPTER SIX: RECOMMENDATIONS AND CONCLUSION.

6.1 Recommendations

The findings from this study suggest that continuing awareness and education be provided in terms of the fatigue-mitigation and fatigue-proofing strategies that promote adequate off-duty rest and recovery time, and the ability to pursue regular, healthy lifestyle habits. Sleep hygiene strategies should be reinforced, the researcher suggests further education and training be made available to emergency medical service providers. Sleep hygiene has proven a valuable pro-active strategy in limiting effects and symptoms associated with fatigue evidenced by those participants who felt rested. The concepts of napping/ rest times require additional study to establish the optimum time and duration for napping/ rest periods. In other more predictable high-risk industries this strategy may be advantageous however due to the unpredictable nature of the emergency medical service; this strategy may not work as intended. Still, some evidence suggests this strategy may be beneficial.

The study data revealed an important area of concern: Nearly half of all the participants experienced symptoms of ill-health at some point, either during their shift work or in their off-duty periods, which may potentially compound, leading to chronic health complications. Although many of the participants indicated that their fatigue management strategies had reduced their perceived experiences of ill-health, it is essential to encourage education and training in these strategies.

The development of these complications, as reported by local participants, reflects international studies and is consistent with the effects and symptoms associated with fatigue, which require urgent attention to limit the risks to individual advanced life support providers and their communities. Furthermore, a continued focus on, and study of, the effects and symptoms associated with fatigue related to health, safety and performance, in advanced life support providers is required. Moreover, the generalisation of fatigue-management strategies from other high-risk environments may not effectively be transferred. Research and implementation of these strategies should continue. This may help to identify the optimal guidelines and strategies for the management of fatigue within the context of emergency medical care services.

6.2 Conclusion

Fatigue-proofing and fatigue-mitigating strategies are changing the way shift work is done, to a more economical way in terms of individual human resources. Locally, safe and effective strategies for fatigue mitigation and fatigue proofing have not as yet been formalised. However, informal fatigue-management strategies have been utilised locally with varying degrees of success. While this study identified a range of strategies that participants believed to be effective in managing their fatigue, there is no sound evidence to support the efficacy of these strategies.

Advanced life support providers had an opportunity to share their valuable personal experiences in this study. After evaluating their self-reported personal experiences, the areas most impacted by the effects and symptoms associated with fatigue were their off-duty times. This included rest and recovery time, and regular lifestyle habits. Some participants were unable to attain an adequate level of rest and recovery, or fulfil their plans while off duty; this was particularly prevalent in the group that had experienced symptoms of ill-health. The associations between the above led to the amplification of fatigue as a result of inadequate rest and recovery, specifically for those who did not practise fatigue-management strategies. This further prevented the participants from eating healthily; being able to take advantage of regular physical activity; participating in healthy social interactions; and ultimately returning to shift duty in a well-rested and refreshed state.

Most participants understood the value of education when it came to sleep hygiene and, accordingly, there was a significant association between knowledge and education on sleep hygiene and their fatigue-management strategies. This knowledge and education provided a platform for the participants to build on their fatigue-management strategies, which had improved their ability to rest and subsequently benefitted their performance. For most, their fatigue management strategies reduced the effects and symptoms associated with fatigue, and in particular their health effects and symptoms, and these participants consequently felt more rested. This was further evidenced when they felt adequately rested and prepared for their shifts and did not require additional fatigue-management strategies during their shift work.

The emergency medical care service is a relatively new profession, compared to other well-known professions such as medicine, nursing, fire-rescue, aviation, transport, and the military. Locally, shift work requirements of the advanced life support providers may necessitate them venturing into these other services, where they face similar fatigue-related challenges during the course of their shift work. Consequently, the emergency medical care service may look to these established professions and industries for guidance and example. Importantly, by doing so, it must be noted that the strategies which had worked in one high-risk environment may not prove generalizable to other environments; in particular to the emergency medical care service setting, which is considered to be dynamic and unpredictable.

Although fatigue-proofing and -mitigating measures are not entirely mandated across these services and industries, emergency medical care providers and other high-risk industry employees have developed, and skilfully adjusted, informal strategies to manage their fatigue within their specific environments. It is possible that these informal fatigue management strategies that were utilised were as a result of necessity that had developed within these high-risk environments and their requirements.

While, internationally and locally, many of these informal fatigue-management strategies would appear, intuitively, to be practical and likely to be successful, strategies within the emergency medical care services should be studied further. Accordingly, it is essential to identify and formalise these strategies into evidence-based guidelines and processes, which should incorporate the reduction of the effects and symptoms associated with fatigue, and improve patient and provider safety, health, and performance.

Advanced life support providers deliver an extraordinary service to their communities and have demonstrated their commitment and loyalty to their chosen profession. They often travel vast distances to reach their patients, through rugged and dangerous areas at all times of the day or night, regardless of prevailing environmental/weather conditions. On-scene they are required to manage their patient, family members, bystanders, and the general progression of the emergency scene, which can be stressful, emotionally charged, and dangerous. The researcher works shifts within the same challenging and dynamic environments, and personal experiences of fatigue have been shared with, and are relatable to, the participants of this study. In the same way the researcher has also utilised fatigue-management strategies in an

attempt to combat the rigours of shift work, and so has experienced similar successes and disappointments. It is the researcher's hope that this study will create awareness around the risks of fatigue and the benefits of utilising fatigue management strategies, and so promote active participation in fatigue management. This will give rise to a safer, more productive, and healthier working environment for those that selflessly give their all to their communities.

References

Akerstedt, T. (2009) 'Sleep Loss and Fatigue in Shift Work ahd SWD', *Sleep Med Clin*, 4(2), pp. 257–271. doi: 10.1016/j.jsmc.2009.03.001.Sleep.

Barger, L. K. Runyon, M. S. Renn, M. L. Moore, C. G. Weiss, P. M. Condle, J. P. Flickinger, K. L. Divecha, A. A. Coppler, P. J. Sequeira, D. J. Lang, E. S. Higgins, J. S. Patterson, P. D. (2018) 'Effect of Fatigue Training on Safety, Fatigue, and Sleep in Emergency Medical Services Personnel and Other Shift Workers: A Systematic Review and Meta-Analysis', *Prehospital Emergency Care*. Taylor & Francis, 22(S1), pp. 58–68. doi: 10.1080/10903127.2017.1362087.

Bérastégui, P. Jaspar, M. Ghuysen, A. Nyssen, A. (2018) 'Fatigue-related risk management in the emergency department: A focus-group study', *Internal and Emergency Medicine*. Springer International Publishing, 13(8), pp. 1273–1281. doi: 10.1007/s11739-018-1873-3.

Bérastégui, P. Jaspar, M. Ghuysen, A. Nyssen, A. (2020) 'Informal fatigue-related risk management in the emergency department : A trade-off between doing well and feeling well', *Safety Science*. Elsevier, 122(September 2019), p. 104508. doi: 10.1016/j.ssci.2019.104508.

Boschman, A. V. S. J. S. and Dresen, M. H. W. F. (2017) 'Appraisal of work ability in relation to job specific health requirements in ambulance workers', *International Archives of Occupational and Environmental Health*. Springer Berlin Heidelberg, 90(1), pp. 123–131. doi: 10.1007/s00420-016-1181-z.

Cash, R. E. Anderson, S. E. Lancaster, K. E. Lu, B. Rivard, M. K. Camargo, C. A. Panchal, A. R. (2020) 'Comparing the Prevalence of Poor Sleep and Stress Metrics in Basic versus Advanced Life Support Emergency Medical Services Personnel', *Prehospital Emergency Care*, 24(5), pp. 644–656. doi: 10.1080/10903127.2020.1758259.

Courtney, J. A., Francis, A. J. P. and Paxton, S. J. (2010) 'Caring for the Carers: Fatigue, Sleep, and Mental Health in Australian Paramedic Shiftworkers', *The Australian and New Zealand Journal of Organisational Psychology*, 3, pp. 32–41. doi: 10.1375/ajop.3.1.32.

Daniel Patterson, Daniel Buysse, Matthew Weaver, Brian Suffoletto, Kyle McManigle, Clifton Callaway, D. Y. (2015) 'NIH Public Access', (1994), pp. 399–411. doi:

10.1016/j.aap.2014.09.028.Emergency.

Daniel Patterson, P. Stephen Higgins, J.A. Van Dongen, H. P. Buysse, D. J. Thackery, R. W. Kupas, D. F. Becker, D. S. Dean, B. E. Lindbeck, G. H. Guyette, F. X. Penner, J. H. Violanti, J. M. Lang, E. S. Martin-Gill, C. (2018) 'Evidence-Based Guidelines for Fatigue Risk Management in', *Emergency Medical Services*, 22, pp. 89–101. Available at: https://www.tandfonline.com/action/journalInformation?journalCode=ipec20.

Dawson, D. Mayger, K. Thomas, M. J. W. Thompson, K. (2015a) 'Fatigue risk management by volunteer fire-fighters: Use of informal strategies to augment formal policy', *Accident Analysis & Prevention*. Pergamon, 84, pp. 92–98. doi: 10.1016/J.AAP.2015.06.008.

Dawson, D. Cleggett, C. Thompson, K. Thomas, M. J. W. (2017) 'Fatigue proofing: The role of protective behaviours in mediating fatigue-related risk in a defence aviation environment', *Accident Analysis and Prevention*. Elsevier Ltd, 99, pp. 465–468. doi: 10.1016/j.aap.2015.10.011.

Dawson, D., Ferguson, S. A. and Vincent, G. E. (2021) 'Safety implications of fatigue and sleep inertia for emergency services personnel', *Sleep Medicine Reviews*. 55, p. 101386. doi: 10.1016/j.smrv.2020.101386.

Department of Basic Education (2014) 'Government Gazette Staatskoerant', *Government Gazette*, 583(37230), pp. 1–4. Available at: http://www.greengazette.co.za/pages/national-gazette-37230-of-17-january-2014-vol-583_20140117-GGN-37230-003.

Department of Health (2014) 'Government Gazette Staatskoerant', *Government Gazette*, 583(37230), pp. 1–4. Available at: http://www.greengazette.co.za/pages/national-gazette-37230-of-17-january-2014-vol-583_20140117-GGN-37230-003.

Department of Health South Africa (2021) 'Government Notices: Regulations Relting Standards for Emergency Medical Services', *Government Gazette*, 94(44161), pp. 3–20.

Donnelly, E. A. Bradford, P. Davis, M. Hedges, C. Socha, D. Morassutti, P. (2019) 'Fatigue and Safety in Paramedicine', *Canadian Journal of Emergency Medicine*, 21(6), pp. 762–765. doi: 10.1017/cem.2019.380.

Ebata, C., Tatsuta, H. and Tatemichi, M. (2017) 'Potential objective biomarkers for fatigue among working women', *Journal of Occupational Health*, 59(3), pp. 286–291. doi:

10.1539/joh.16-0206-BR.

Emanuel E, Wendler D, G. C. (2008) ‘An ethical framework for biomedical research. The Oxford Textbook of Clinical Research Ethics’, pp. 123–135.

Falender, C. A. and Shafranske, E. P. (2004) *Carol A. Falender, Edward P. Shafranske-Clinical Supervision- A Competency-Based Approach-American Psychological Association (APA) (2004)*.

Ferguson, S. A., Neall, A. and Dorrian, J. (2013) ‘Strategies used by healthcare practitioners to manage fatigue- related risk : beyond work hours Central Queensland University School of Psychology , Social Work and Social Policy’, 7(2), pp. 24–33.

Freedman-Weiss, M. R. Mollie R. Heller, D. R. White, E. M. Chiu, A. S. Jean, R. A. Yoo, P. S. (2021) ‘Driving Safety Among Surgical Residents in the Era of Duty Hour Restrictions’, *Journal of Surgical Education*. Elsevier, 78(3), pp. 770–776. doi: 10.1016/J.JSURG.2020.08.041.

Goodson, B. (2023) *Fatigue: Sleeping Giant of the Workplace -- Occupational Health & Safety*, *Occupational Health & Safety*. Available at: https://ohsonline.com/articles/2023/01/24/sleeping-giant-of-the-workplace.aspx (Accessed: 19 January 2024).

Govender, K. Grainger, L. Naidoo, R. MacDonald, R. (2012) ‘The pending loss of advanced life support paramedics in South Africa’, *African Journal of Emergency Medicine*. African Federation for Emergency Medicine, 2(2), pp. 59–66. doi: 10.1016/j.afjem.2011.11.001.

Härmä, M. Karhula, K. Ropponen, A. Puttonen, S. Koskinen, A. Ojajärvi, A. Hakola, T. Pentti, J. Oksanen, T. Vahtera, J. Kivimäki, M. (2018) ‘Association of changes in work shifts and shift intensity with change in fatigue and disturbed sleep: A within-subject study’, *Scandinavian Journal of Work, Environment and Health*, 44(4), pp. 394–402. doi: 10.5271/sjweh.3730.

Health Professions Council of South Africa (2007) ‘Health Professions Council of South Africa MINUTES’, (September), p. 2011. Available at: http://www.hpcsa.co.za.

Health Professions Council of South Africa (2016a) *National Patients’ Rights Charter*. National P. Pretoria: Health Professions Council of South Africa.

Health Professions Council of South Africa (2016b) *Professional Boards - HPCSA*, *Overview-Professional Board for Emergency Care*. Available at: http://www.hpcsa.co.za.

Health Professions Council of South Africa (2018a) *Clinical Practice Guidlines*, *Clinical Practice Guidelines Update*. Available at: https://www.hpcsa.co.za/Uploads/editor/UserFiles/downloads/emergency_care/CLINICAL_PRACTICE_GUIDELINES_PROTOCOLS_2018.pdf.

Health Professions Council of South Africa (2018b) *Clinical Practice Guidelines Update*, (July), pp. 97–102. Available at: https://www.hpcsa.co.za/Uploads/editor/UserFiles/downloads/emergency_care/CLINICAL_PRACTICE_GUIDELINES_PROTOCOLS_2018.pdf.

Health Professions Council of South Africa (2018c) 'List of Capabilities and Medications', p. 11.

Henrich, N. Ayas, N. T. Stelfox, H. T. Peets, A. D. (2016) 'Cognitive and Other Strategies to Mitigate the Effects of Fatigue. Lessons from Staff Physicians Working in Intensive Care Units', *Annals of the American Thoracic Society*. 13(9), pp. 1600–1606. doi: 10.1513/ANNALSATS.201512-817OC.

Hsiao, H., Chang, J. and Simeonov, P. (2018) 'Preventing Emergency Vehicle Crashes: Status and Challenges of Human Factors Issues', *Human Factors*, 60(7), pp. 1048–1072. doi: 10.1177/0018720818786132.

Van Huyssteen, N. (2016) 'A Legal Analysis of the Emergency Medical Services in South Africa', pp. i–186. Available at: https://repository.up.ac.za/bitstream/handle/2263/60108/VanHuyssteen_Legal_2017.pdf?sequence=1&isAllowed=y.

Johns, M. W. (1991) 'A new method for measuring daytime sleepiness: The Epworth sleepiness scale', *Sleep*, 14(6), pp. 540–545. doi: 10.1093/sleep/14.6.540.

Kagamiyama, H. and Yano, R. (2018) 'Relationship between subjective fatigue, physical activity, and sleep indices in nurses working 16-hour night shifts in a rotating two-shift system', *Journal of Rural Medicine*, 13(1), pp. 26–32. doi: 10.2185/jrm.2951.

Khoshakhlagh, A. H. Al Sulaie, S. Yazdanirad, S. Orr, R. M. Dehdarirad, H. Milajerdi, A. (2023) 'Global prevalence and associated factors of sleep disorders and poor sleep quality among firefighters: A systematic review and meta-analysis', *Heliyon*. Elsevier Ltd, 9(2), p. e13250. doi: 10.1016/j.heliyon.2023.e13250.

KwaZulu-Natal Department of Health (2023) *KwaZulu-Natal Emergency Services*. Available at: http://www.kznhealth.gov.za/ems.htm (Accessed: 13 January 2024).

Macfarlane, C. (2004) 'The pre-hospital trauma and emergency doctor', *Continuing Medical Education*, 22(6), p. 311.

MacFarlane, C., Van Loggerenberg, C. and Kloeck, W. (2005) 'International EMS systems in South Africa: past, present, and future', *Resuscitation*. 64(2), pp. 145–148. doi: 10.1016/J.RESUSCITATION.2004.11.003.

MacQuarrie, A. J. Robertson, C. Micalos, P. Crane, J. High, R. Drinkwater, E. Wickham, J. (2018) 'Fit for duty: The health status of New South Wales Paramedics', *Irish Journal of Paramedicine*, 3(2), pp. 1–10. doi: 10.32378/ijp.v3i2.109.

Mansouri, T. Hostler, D. Temple, J. L. Clemency, B. M. (2021) 'Eating and Physical Activity Patterns in Day and Night Shift EMS Clinicians', *Prehospital Emergency Care*. doi: 10.1080/10903127.2021.1996662.

Maree, K. (2007) *First Steps in Research. Pretoria: Van Schaik Publishers.* 2nd Edition. Hatfield Pretoria.: Van Schaik.

Maree, K. Creswell, J. W. Ebersohn, L. Eloff, I. Ferreira, R. Ivankova, N. V. Jansen, J. D. Nieuwenhuis, J. Pietersen, J. Clark, V. L. P. (2016) *First steps in research*. 2nd edition. Edited by K. Maree. Pretoria: Van Schaik.

Martin-Gill, C. Barger, L. K. Moore, C. G. Higgins, J. S. Teasley, E. M. Weiss, P. M. Condle, J. P. Flickinger, K. L. Coppler, P. J. Sequeira, D. J. Divecha, A. A. Matthews, M. E. Lang, E. S. Patterson, P. D. (2018) 'Effects of Napping During Shift Work on Sleepiness and Performance in Emergency Medical Services Personnel and Similar Shift Workers: A Systematic Review and Meta-Analysis', *Prehospital Emergency Care*. Taylor & Francis, 22(S1), pp. 47–57. doi: 10.1080/10903127.2017.1376136.

Morris, M. B. Howland, J. P. Amaddio, K. M. Gunzelmann, G. (2020) ‘Aircrew Fatigue Perceptions, Fatigue Mitigation Strategies, and Circadian Typology’, *Aerospace Medicine and Human Performance*, 91(4), pp. 363–368. doi: 10.3357/AMHP.5396.2020.

Myers, J. B. Wages, R. K. Rowe, D. Nollette, C. Touchstone, M. Sinclair, J. Mund, E. L. Eberly, J. M. Montes, J. D. Sherlock, R. J. Barger, L. K. Drummond, S. P. A. Gurubhagavatula, I. (2018) ‘What an Evidence-based Guideline for Fatigue Risk Management Means for Us: Statements From Stakeholders’, *Prehospital Emergency Care*, 22, pp. 113–118. doi: 10.1080/10903127.2017.1380100.

Nayak, M. and Narayan, K. A. (2019) ‘Strengths and Weakness of Online Surveys’, *IOSR Journal of Humanities and Social Sciences (IOSR-JHSS)*, 24(5), pp. 31–38. doi: 10.9790/0837-2405053138.

Ogeil, R. P. Barger, L. K. Lockley, S. W. O’Brien, C. S. Sullivan, J. P. Qadri, S. Lubman, D. I. Czeisler, C. A. Rajaratnam, S. M. W. (2018) ‘Cross-sectional analysis of sleep-promoting and wake-promoting drug use on health, fatigue-related error, and near-crashes in police officers’, *BMJ Open*, 8(9), p. e022041. doi: 10.1136/bmjopen-2018-022041.

P. Daniel Patterson, Sharon Klapec, Matthew D. Weaver, Francis X. Guyette, Thomas E. Platt, and Daniel J. Buysse, M. (2016) *Differences in paramedic fatigue before and after changing from a 24-hour to 8-hour shift schedule: A case report*. doi: 10.3109/10903127.2015.1025158.

Paramedics Australasia (2012) ‘Paramedicine Role Descriptions’, pp. 1–23. Available at: https://www.paramedics.org/content/2009/07/PRD_211212_WEBONLY.pdf.

Patterson, P. D. Weaver, M. D. Frank, R. C. Warner, C. W. Martin-Gill, C. Guyette, F. X. Fairbanks, R. J. Hubble, M. W. Songer, T. J. Callaway, C. W. Kelsey, S. F. Hostler, D. (2012) ‘Association between poor sleep, fatigue, and safety outcomes in emergency medical services providers’, *Prehospital Emergency Care*, 16(1), pp. 86–97. doi: 10.3109/10903127.2011.616261.

Patterson, P. D., Higgins, J. S. Lang, E. S. Runyon, M. S. Barger, L. K. Studnek, J. R. Moore, C. G. Robinson, K. Gainor, D. Infinger, A. Weiss, P. M. Sequeira, D. J. Martin-Gill, C. (2017) ‘Evidence-Based Guidelines for Fatigue Risk Management in EMS: Formulating Research Questions and Selecting Outcomes’, *Prehospital Emergency Care*, pp. 149–156. doi:

10.1080/10903127.2016.1241329.

Patterson, P. D., Moore, C. G. Guyette, Frank X. Doman, J. M. Sequeira, D. Werman, H. A. Swanson, D. Hostler, D. Lynch, J. Russo, L. Hines, L. Swecker, K. Runyon, M. S. Buysse, D. J. (2017) 'Fatigue mitigation with SleepTrackTXT2 in air medical emergency care systems: Study protocol for a randomized controlled trial', *Trials*. doi: 10.1186/s13063-017-1999-z.

Patterson, P. D., Higgins, J. S. Van Dongen, H. P. A. Buysse, D. J. Thackery, R. W. Kupas, D. F. Becker, D. S. Dean, B. E. Lindbeck, G. H. Guyette, F. X. Penner, J. H. Violanti, J. M. Lang, E. S. Martin-Gill, C. (2018) 'Evidence-Based Guidelines for Fatigue Risk Management in Emergency Medical Services', *Prehospital Emergency Care*. Taylor & Francis, 22(S1), pp. 89–101. doi: 10.1080/10903127.2017.1376137.

Patterson, P. D., Weaver, M. D. Fabio, A. Teasley, E. M. Renn, M. L. Curtis, B. R. Matthews, M. E. Kroemer, A. J. Xun, X. Bizhanova, Z. Weiss, P. M. Sequeira, Denisse J. Coppler, P.J. Lang, E. S. Higgins, J. Stephen. (2018) 'Reliability and Validity of Survey Instruments to Measure Work-Related Fatigue in the Emergency Medical Services Setting: A Systematic Review', *Prehospital Emergency Care*, 22, pp. 17–27. doi: 10.1080/10903127.2017.1376134.

Pirrallo, R. G. Loomis, C. C. Levine, R. Woodson, T. (2012) 'The prevalence of sleep problems in emergency medical technicians', *Sleep and Breathing*. doi: 10.1007/s11325-010-0467-8.

Przepiorka, D. (2002) *Legal and Regulatory Affairs workshop summary.*, *Cytotherapy*. doi: 10.1080/146532402317251563.

Puttonen, S., Härmä, M. and Hublin, C. (2010) 'Shift work and cardiovascular disease - Pathways from circadian stress to morbidity', *Scandinavian Journal of Work, Environment and Health*, 36(2), pp. 96–108. doi: 10.5271/sjweh.2894.

QuestionPro (2005) 'QuestionPro'. Austin Texas U.S.A: QuestionPro. Available at: www.questionpro.com.

Ramey, S. MacQuarrie, A. Cochrane, A. McCann, I. Johnston, C. W. Batt, A. M. (2019) 'Drowsy and dangerous? Fatigue in paramedics: an overview', *Irish Journal of Paramedicine*, 4(1). doi: 10.32378/ijp.v4i1.175.

Raosoft (2004) 'Raosoft sample calculator'. Seattle U.S.A: Raosoft Inc. Available at:

www.raosoft.com/samplesize.html.

Reinecke, C. R. (2017) ‘Beyond Vicarious Trauma: Exploring Adversarial Growth in a Sample of South African Paramedics’.

Renkiewicz, G. K. and Hubble, M. W. (2021) ‘Secondary Traumatic Stress in Emergency Services Systems (STRESS) Project: Quantifying and Predicting Compassion Fatigue in Emergency Medical Services Personnel’, *Prehospital Emergency Care*. Taylor & Francis, 0(0), pp. 1–12. doi: 10.1080/10903127.2021.1943578.

Republic of South Africa (2003) *Government Gazette*, *Emergency Medical Services Regulations*. Republic of South Africa. Available at: www.gpwonline.co.za.

Republic of South Africa (2009) *Health Professions Act 56 of 1974*, *Government Gazette 31859*. Available at: http://www.hpcsa.co.za/Uploads/editor/UserFiles/downloads/legislations/acts/health_professions_ct_56_1974.pdf.

Ruggiero, J. S. and Redeker, N. S. (2014) ‘Effects of Napping on Sleepiness and Sleep-Related Performance Deficits in Night-Shift Workers: A Systematic Review’, *Biological Research for Nursing*, 16(2), pp. 134–142. doi: 10.1177/1099800413476571.

Satterfield, B. C. and Van Dongen, H. P. A. (2013) ‘Occupational fatigue, underlying sleep and circadian mechanisms, and approaches to fatigue risk management’, *Fatigue: Biomedicine, Health and Behavior*, 1(3), pp. 118–136. doi: 10.1080/21641846.2013.798923.

Wilson, K. M. Weis, E. (2011) ‘The Epidemiology and Health Effects of Tobacco Use’, *Current Pediatric Reviews*, 7(2), pp. 76-80.

Sofianopoulos, S. Williams, B. Archer, F. Thompson, B. (2011) ‘The exploration of Emergency Primary Health Care.’, *Journal of Emergency Primary Health Care*, 9(1).

Soares, S. Sara Ferreira, A. C. (2020) ‘Drowsiness and distraction while driving: A study based on smartphone app data’, *Journal of Safety Research Volume 72, February 2020, Pages 279-285*, volume 72(February 2020), pp. 279–285. doi: https://doi.org/10.1016/j.jsr.2019.12.024.

Statistics South Africa (2018) *Provincial Profile KwaZulu-Natal, Community Survey 2016 (report number 03-01-10)*. Available at: www.statssa.gov.za.

Stedman, T. L. (2006) 'Stedman's Medical Dictionary, Volume 1'. Lippincott Williams & Wilkins, p. 2345. Available at: https://cmc.marmot.org/Record/.b33074264 (Accessed: 1 April 2023).

Stein, C. *et al.* (2016) 'Access to out-of-hospital emergency care in Africa: Consensus conference recommendations', *African Journal of Emergency Medicine*. African Federation for Emergency Medicine, 6(3), pp. 158–161. doi: 10.1016/j.afjem.2016.08.008.

Stein, C., Wallis, L. and Adetunji, O. (2015) 'The effect of the emergency medical services vehicle location and response strategy on response times', *South African Journal of Industrial Engineering*, 26(2), pp. 26–40. doi: 10.7166/26-2-1078.

Studnek, J. R. Infinger, A. E. Renn, M. L. Weiss, P. M. Condle, J. P. Flickinger, K. L. Kroemer, A. J. Curtis, B. R. Xun, X. Divecha, A. A. Coppler, P. J. Bizhanova, Z. Sequeira, D. J. Lang, E. Higgins, J. S. Patterson, P. D. (2018) 'Effect of Task Load Interventions on Fatigue in Emergency Medical Services Personnel and Other Shift Workers: A Systematic Review', *Prehospital Emergency Care*, 22, pp. 81–88. doi: 10.1080/10903127.2017.1384874.

Takeyama, H. Itani, T. Tachi, N. Sakamura, O. Murata, K. Inoue, T. Takanishi, T. Suzumura, H. Niwa, S. (2009) 'Effects of a modified ambulance night shift system on fatigue and physiological function among ambulance paramedics', *Journal of Occupational Health*, 51(3), pp. 204–209. doi: 10.1539/joh.L7040.

Temple, J. L. Hostler, D. Martin-gill, C. Moore, C. G. Weiss, P. M. Sequeira, D. J. Condle, J. P. Lang, E. S. Higgins, S. Patterson, P D. (2018) 'Systematic Review and Meta-analysis of the Effects of Caffeine in Fatigued Shift Workers : Implications for Emergency Medical Services Personnel, *Prehospital Emergency Care*. Taylor & Francis, 22(S1), pp. 37–46. doi: 10.1080/10903127.2017.1382624.

University of Pretoria (2006) 'The African Ubuntu Philosophy', *African Philosophy*, pp. 126–164. Available at: https://repository.up.ac.za/bitstream/handle/2263/28706/04chapter4.pdf?sequence=5.

Vincent-Lambert, C. (2015) *Vincent-Lambert C. International perspectives: South... - Google Scholar*, *Ambulance Services: Leadership and Management Perspectives*. Available at: https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&as_vis=1&q=Vincent-Lambert+C.+International+perspectives%3A+South+African+ambulance+services+in+2020.&btnG= (Accessed: 10 January 2024).

De Vries, J., Michielsen, H. J. and Van Heck, G. L. (2003) 'Assessment of fatigue among working people: A comparison of six questionnaires', *Occupational and Environmental Medicine*, 60(SUPPL. 1), pp. 10–15. doi: 10.1136/oem.60.suppl_1.i10.

Washington, P. and Falls, C. (2018) 'National Association of State EMS Officials. FATIGUE IN EMS RISK MANAGEMENT GUIDELINES GO LIVE !!'

Whitney, P. Hinson, J. M. Satterfield, B. C. Grant, D. A. Honn, K. A. Van Dongen, H. P. A. (2017) 'Sleep Deprivation Diminishes Attentional Control Effectiveness and Impairs Flexible Adaptation to Changing Conditions', *Scientific Reports*. Springer US, 7(1), pp. 1–9. doi: 10.1038/s41598-017-16165-z.

Winwood, P. C. Winefield, A. H. Dawson, D. Lushington, K. (2005) 'Development and validation of a scale to measure work-related fatigue and recovery: The Occupational Fatigue Exhaustion/Recovery scale (OFER)', *Journal of Occupational and Environmental Medicine*, 47(6), pp. 594–606. doi: 10.1097/01.jom.0000161740.71049.c4.

World Health Organization (2008) 'European Union Report of an assessment project.', *World Health*.

APPENDICES

Appendix A - Ethics committee approval: Durban University of technology.

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12 October 2021

Mr B Greyling
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Durban

Dear Mr Greyling

An evaluation of fatigue management strategies utilized by advanced life support providers in Kwa-Zulu Natal

I am pleased to inform you that Full Approval has been granted to your proposal.

The Proposal has been allocated the following Ethical Clearance number **IREC 208/21**. Please use this number in all communication with this office.

Approval has been granted for a period of **ONE YEAR**, before the expiry of which you are required to apply for safety monitoring and annual recertification. Please use the Safety Monitoring and Annual Recertification Report form which can be found in the Standard Operating Procedures [SOP's] of the IREC. This form must be submitted to the IREC at least 3 months before the ethics approval for the study expires.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the IREC according to the IREC SOP's.

Please note that any deviations from the approved proposal require the approval of the IREC as outlined in the IREC SOP's.

Yours Sincerely

Professor J K Adam
Chairperson: IREC

Appendix B - Letter of information:

LETTER OF INFORMATION

Title of the Research Study: An evaluation of fatigue management strategies utilized by advanced life support providers in KwaZulu-Natal.

Principal Investigator/s/researcher: Bryan Greyling (MHSc EMC&R candidate)

Co-Investigator/s/supervisor/s: Mrs. Dagmar Muhlbauer, MTech EMC. Dr. Timothy Hardcastle, MBChB, MMed (Chir); PhD, FCS (SA); Trauma (HPCSA)

Brief Introduction and Purpose of the Study:
This study will take place locally within Kwa-Zulu Natal and you are invited to participate and contribute your valued experience to the research. Currently within the emergency medical services, the development and implementation of fatigue management strategies is a relatively new concept albeit the effects and symptoms associated with fatigue on occupational performance, safety, as well as the health of shift workers are known and have been documented. As such it is a challenge to safely manage fatigue in local advanced life support providers.

The aim of this study is to gain an understanding into the informal fatigue management strategies used and to evaluate if they safeguard the advanced life support provider from operating in a fatigued state. The current use of informal fatigue proofing and mitigation systems in South Africa is unclear. It is reasonable to deduce that local advanced life support providers practice informal fatigue management strategies in order to limit and adapt to shift working fatigue. Strategies must be developed to safely manage fatigue or techniques defined to expand on current informal practices in order to improve on the performance, safety, and health of advanced life support providers in the South African context.

The research problem that will be addressed is to evaluate which informal fatigue management strategies are utilized and their frequency by local advanced life support providers in the presence or anticipation of shift working fatigue. Do the advanced life support providers who utilize informal fatigue management strategies perceive them to be effective in limiting and adapting to shift work fatigue? Thereby engaging in this study, reporting on the frequency and severity of the effects and symptoms associated with fatigue and which fatigue management strategies were used and how effective they are, may provide valuable insight.

Welcome:
Hello, I hope this informational letter finds you in good health. My name is Bryan Greyling and I am currently registered with the Durban University of Technology, Department of Emergency Medical Care and Rescue with the aim of completing my Master's Degree. I am setting out to answer the above research questions about the fatigue that you experience and how you manage that fatigue

therefore I humbly invite you to participate and contribute your valued experiences to the research. Please feel free to ask as many questions as you like during the course of the survey, any engagement will be gladly invited.

What is research?
Research is the creation of new knowledge or to make use of existing knowledge in an innovative way in order to make sense of and to generate new concepts or to refine existing methods that leads to new and exciting outcomes.

Outline of the Procedures:
You are invited to participate in an anonymous online survey questionnaire. The online survey questionnaire should take approximately 15 minutes to complete. In order to participate in this survey, you should fulfill the following inclusion criteria:
You should be an advanced life support provider registered with the Health Professions Council of South Africa on the ANT or ECP register.
Be operational and work shifts in the role of an advanced life support provider within the province of Kwa-Zulu Natal.
You will be able to complete the online survey questionnaire at your leisure and where you choose in safety and in private. Once you acknowledge consent the questionnaire will begin. The survey questionnaire will contain basic demographic questions and will lead into your experiences related to fatigue. Following this it will require your input on how you manage fatigue, which fatigue management techniques you make use of, how often, and whether or not you feel they are effective. The outcomes of this study will provide evidence on the relationship between your experienced fatigue and the effective use of informal fatigue management strategies.

Risks or Discomforts:
You may feel uncomfortable disclosing the extent of fatigue you experience at work, as negative connotations may be associated with fatigue and are undesirable in the performance of your job role as an advanced life support provider. This will be mitigated by maintaining confidentiality and anonymity.

Reasons that you may withdraw from the Study:
Withdrawal from the study is completely at your own discretion, with no consequences, should you wish to withdraw. Participation is completely voluntary and anonymous. Once you have submitted the online survey questionnaire for assessment you can no longer withdraw from the study.

Benefits:
You may benefit directly from the recognition of the effects and symptoms associated with fatigue and the subsequent fatigue management strategies in the work place, and indirectly through the employers taking cognizance of the benefits of implementing formal fatigue management strategies in the work place.

The researcher may publish his findings.

Remuneration:
There will be no remuneration for participation in this study.

Costs of the Study:
There is no cost to you for participation in this study.

Confidentiality:
At all times your confidentiality will be maintained. The survey will require no identifying information at any stage during the questionnaire and is anonymous. You will be allocated a participant number during the data analysis process. The data collected will be stored in a password protected file on a password protected laptop. Your participation is thus anonymous and only the researcher and supervisors will have access to the data.

Results:
Results of this study may add to further research in this field, with the aim of providing locally relevant pre hospital data and from this develop a tool for fatigue management amongst South African emergency medical care employers and employees alike.

Research-related Injury:
In the event that you may be at risk of self-harm or risky behavior during the course of this research, the researcher may approached you after the questionnaire is evaluated. There will be an arrangement to offer you support and counseling without any need for identification or prejudice. Prior to the commencement of the study a psychosocial support structure will be identified who would provide this support, life-style education or medical intervention if needed.

Persons to contact in the Event of Any Problems or Queries:
Please contact the researcher Bryan Greyling (0795745741), my supervisor Mrs. Dagmar Muhlbauer (082 444 3671), or the Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the Director: Research and Postgraduate Support Dr L Linganiso on 031 373 2577 or researchdirector@dut.ac.za.

Appendix C - Letter of Consent:

CONSENT

Full Title of the Study: An evaluation of fatigue management strategies utilized by advanced life support providers in KwaZulu-Natal.
Names of Researcher/s: Bryan Greyling (MHSc EMC&R candidate)

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, Bryan Greyling, about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: IREC 208/21 .
- I have also received read and understood the above information letter regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerized system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may

  relate to my participation will be made available to me.

I confirm that I agree to take part in this study.

Please choose one of the following answers:
_____ Agree
_____Disagree

Appendix D - Survey Questionnaire:

This questionnaire is designed for you to provide your personal experiences related to shift-work fatigue and how you manage that fatigue. Please take your time to understand the questions and use your personal experiences to provide your best responses.

Section A: Demographical data

1. How old are you?

21-25 years	26-30 years	31-35 years	36-40 years	Older than 40

2. How many years' experience as an advanced life support provider do you have?

1-2 years' experience	>2-5 years' experience	>5-10 years' experience	>10-15 years' experience	More than 15 years 'experience

3. Please indicate your sex.

Male	Female

4. Do you work 12-hour shifts?

Yes	No

5. Do you work 24-hour shifts?

Yes	No

6. Do you work standby shifts?

Yes	No

Section B:

Fatigue has been described as a subjective experience, in that one individual's personal experience of fatigue may differ to that of the next individual. Differences may be a result of certain attributes, health, age, or lifestyle. This study focuses on the effects and symptoms of fatigue that may directly affect your health, safety, and performance. This includes the behavioural and physical effects of fatigue, shift performance, fatigue-related errors, and inter-shift recovery.

7. In the last month have you, in your opinion, made a clinical management error whilst on shift, due to fatigue?

Yes	No

8. Has fatigue, in your opinion, ever compromised yours, or your patient's, safety at work?

1- Not at all.	2-Occasionally	3 - On average once a shift cycle	4 - On average once a shift	5 - All the time.

9. How often do you find that fatigue affects your ability to make clinical management decisions efficiently?

1- Not at all.	2-Occasionally	3 - On average once a shift cycle	4 - On average once a shift	5 - All the time.

10. Do you find it increasingly difficult to retrieve and process information safely as your shift cycle progresses?

1 - Not at all.	2-Occasionally	3 - On average once a shift cycle	4 - On average once a shift	5 - All the time.

11. Do you find maintaining focus, motivation, or productivity increasingly difficult as your shift cycle progresses?

1 - Not at all.	2-Occasionally	3 - On average once a shift cycle	4 - On average once a shift	5 - All the time.

12. How often, in your opinion, do you retrospectively think that you could have done more for your patient?

1 - Not at all.	2-Occasionally	3 - On average once a shift cycle	4 - On average once a shift	5 - All the time.

13. During your shift cycle do you notice irritability, hastiness, or even a lack of empathy occurring?

1 - Not at all.	2-Occasionally	3 - On average once a shift cycle	4 - On average once a shift	5 - All the time

14. How often do you have symptoms such as headaches, visual disturbances, temperature dysregulation, or sleepiness?

1- Not at all.	2-Occasionally	3- On average once a shift cycle	4- On average once a shift	5- All the time.

15. How often do you find it difficult to maintain adequate patient monitoring?

1- Not at all.	2-Occasionally	3- On average once a shift cycle	4- On average once a shift	5- All the time.

16. In your opinion, how often do you lack physical energy?

1- Not at all.	2-Occasionally	3- On average once a shift cycle	4- On average once a shift	5- All the time.

17. Do you feel that you recover adequately in-between your shifts?

1- Not at all	2- Occasionally	3- All the time

18. Do you feel that fatigue prevents you from achieving your plans when you are off duty?

1- Not at all.	2- Occasionally.	3- All the time.

Section C:

During shift work, certain techniques are often utilised to resist the effects or symptoms of fatigue. Methods used may include fatigue proofing, such as ensuring adequate rest prior to your shift, self-regulation, and error monitoring by double-checking your work and including checks. In order to evaluate the effectiveness and the frequency of these methods, please provide your best response to the following statements.

19. I have adequate knowledge of sleep patterns and rest strategies in order to recover effectively from the effects of fatigue.

1- Yes	2- No.

20. I avoid heavy meals before starting my shift.

1- Not at all.	2-Occasionaly.	3- All the time.

21. I exercise regularly for an hour three times per week.

1- Not at all.	2- Occasionally.	3- All the time.

22. I ensure that I get appropriate rest in a favourable environment before starting my shift.

1- Not at all.	2- Occasionally.	3- All the time

23. I complete my patient report forms timeously, rather than letting them pile up.

1- Not at all.	2-Occasionally	3- On average once a shift cycle	4- On average once a shift	5- All the time.

24. I focus intensely on my tasks so as to avoid mistakes.

1- Not at all.	2-Occasionally	3- On average once a shift cycle	4- On average once a shift	5- All the time.

25. I rely more on manuals, algorithms, and protocols than memory to alleviate the cognitive load.

1- Not at all.	2-Occasionally	3- On average once a shift cycle	4- On average once a shift	5- All the time.

26. I focus on one task at a time rather than multi-tasking.

1- Not at all.	2-Occasionally	3- On average once a shift cycle	4- On average once a shift	5- All the time.

27. I engage on a personal level with my patient rather than distancing myself.

1- Not at all.	2-Occasionally	3- On average once a shift cycle	4- On average once a shift	5- All the time.

28. I delegate secondary tasks to my colleagues and perform the primary ones myself.

1- Not at all.	2-Occasionally	3- On average once a shift cycle	4- On average once a shift	5- All the time.

29. I leave less urgent treatment procedures to be taken care of later in hospital.

1- Not at all.	2-Occasionally	3- On average once a shift cycle	4- On average once a shift	5- All the time.

30. I double-check my drug choice and dose.

1- Not at all.	2-Occasionally	3- On average once a shift cycle	4- On average once a shift	5- All the time.

31. I verbalise procedures to myself / colleagues to make sure that I don't forget anything.

1- Not at all.	2-Occasionally	3- On average once a shift cycle	4- On average once a shift	5- All the time.

32. I verbalise that I am tired so that my colleagues can pay more attention to my actions.

1- Not at all.	2-Occasionally	3- On average once a shift cycle	4- On average once a shift	5- All the time.

33. I review my cases to identify any errors that I may have made, either to myself or with a colleague.

1- Not at all.	2-Occasionally	3- On average once a shift cycle	4- On average once a shift	5- All the time.

Section D:

This section will identify the techniques that you use to try to overcome and adapt to the fatigue you've experienced while on shift. Please provide your best response to the statements.

34. In your opinion are you able to identify the symptoms of fatigue?

1- Yes.	2- No.

35. I make use of caffeine (coffee or energy drinks), or a quick snack, to relieve the effects of fatigue.

1- Not at all.	2-Occasionally	3- On average once a shift cycle	4- On average once a shift	5- Multiple times during my shift.

36. I take opportunistic naps/rest periods to re-energise.

1- Not at all.	2-Occasionally	3- On average once a shift cycle	4- On average once a shift	5- All the time.

37. I try to keep on the move to avoid crashing (falling asleep).

1- Not at all.	2-Occasionally	3- On average once a shift cycle	4- On average once a shift	5- All the time.

38. I anticipate upcoming tasks and try to have them done as soon as practical, to have more spare time later.

1- Not at all.	2-Occasionally	3- On average once a shift cycle	4- On average once a shift	5- All the time.

39. I take advantage of spare time during my shift to have non-work-related chats.

1- Not at all.	2-Occasionally	3- On average once a shift cycle	4- On average once a shift	5- Multiple times during my shift.

40. I splash my face with cold water.

1- Not at all.	2-Occasionally	3- On average once a shift cycle	4- On average once a shift	5- Multiple times during my shift.

41. I go outside for fresh air or a tobacco product.

1- Not at all.	2-Occasionally	3- On average once a shift cycle	4- On average once a shift	5- Multiple times during my shift.

42. I listen to loud music while driving, have the air conditioning on cold, or I have the windows open.

1- Not at all.	2-Occasionally	3- On average once a shift cycle	4- On average once a shift	5- All the time.

Section E:

The goal of this study is to evaluate the fatigue management strategies that you use. It is important to gauge the effectiveness of the techniques that you use to resist and overcome fatigue.

43. In your opinion do your fatigue management strategies that you use improve your clinical management and safety?

1- Yes.	2- No.

44. Do you agree that your fatigue management strategies improve your focus, motivation, and pro-activity?

1- Not at all.	2-Occasionally when used.	3- On average once a shift cycle.	4- On average only once a shift.	5- Every time when used.

45. When practising these fatigue management strategies, how often do they reduce your symptoms of fatigue?

1- Not at all.	2-Occasionally when used.	3- On average once a shift cycle.	4- On average only once a shift.	5- Every time when used.

46. Are you adequately rested and ready before your shift cycle?

1- Not at all.	2-Occasionally	3- On average minimally in-between my shift cycles.	4- On average only once in-between my shifts.	5- All the time.

47. How often, in your opinion, does fatigue interfere with your regular lifestyle habits? (This may include socialising, eating and exercising, for example)

1- Not at all.	2-Occasionally	3- On average once in-between an off shift cycle	4- On average once in-between shifts	5- All the time.

48. Do you recommend using fatigue management strategies to reduce the effects and symptoms of fatigue?

1- Yes	2- No

49. Do you feel that your fatigue management strategies are successful?

Yes	No

This survey questionnaire is complete. Thank you for your valued input.

Appendix E - Declaration letter for statistical services:

15 Butterfield Bend
Parklands North
Cape Town
7441

10 May 2023
To whom it may concern

I, Tonya Esterhuizen, provided statistical services for Mr Bryan Greyling's Masters' dissertation titled '' An evaluation of fatigue management strategies utilized by advanced life support providers in KwaZulu-Natal''.

The statistical analysis reflected the aims and objectives for the research study that was provided. The requirements, ideas, and data provided for statistical analysis were that of Mr Greyling. The IBM SBSS version 27 was used to analyse the data.

Yours sincerely

Tonya Esterhuizen

Biostatistician

Tonya.esterhuizen7@gmail.com

Contact: 0837855497

Appendix F - Declaration letter for language editing service:

ETHEL ROSS

English language editing and proofreading

23 May 2023

To whomever it may concern:

This letter serves to confirm that I worked as the proofreader and language editor on Bryan Greyling's Master's thesis:

AN EVALUATION OF FATIGUE MANAGEMENT STRATEGIES UTILIZED BY ADVANCED LIFE SUPPORT PROVIDERS IN KWAZULU-NATAL

In no way did I change the content.

Yours faithfully

Ethel Ross (BA Hons; H Dip Ed)

Email: clanross1@icon.co.za Tel: 083 954 5412