

**ASSESSMENT OF ULTRAVIOLET RADIATION EXPOSURE AMONGST
MILITARY OUTDOOR WORKERS: A CASE STUDY OF MILITARY OUTDOOR
WORKERS AT LOHATLA, NORTHERN CAPE**

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DECLARATION

DECLARATION WITH REGARD TO INDEPENDENT WORK

I, Siphon David Galawe, student number (_____), hereby declare that this research report is my work. It is submitted for the master's degree in environmental health at the Central University of Technology, Free State. It has not been submitted before for any degree or examination at this or any other university.

SIGNATURE OF STUDENT

DATE

ABSTRACT

Background: Ultraviolet radiation (UVR) exposure poses significant health risks, particularly for individuals engaged in outdoor occupations. Military personnel, due to their extensive time spent in outdoor environments, are particularly vulnerable to the adverse effects of UVR, which can lead to skin damage, eye disorders, and increased risk of skin cancer. This study focuses on assessing UVR exposure among military outdoor workers stationed in Lohatla, Northern Cape, an area characterised by its intense solar radiation. By measuring ambient UVR levels and correlating them with self-reported health outcomes, the research aims to enhance the understanding of the exposure risks faced by military personnel. The findings are intended to inform the development of effective protective strategies and health guidelines tailored to this unique occupational group.

Methodology: A cross-sectional study was conducted among military outdoor workers in Lohatla, Northern Cape, over three months from December 2024 to February 2025. The study involved the deployment of UV dosimeters to measure ambient UVR levels at designated outdoor work sites. Dosimeters were strategically placed in unobstructed areas to ensure accurate readings representative of daily UVR exposure. Data was collected on two separate occasions for each participant, specifically on the first and last days of each bi-weekly monitoring period. In addition to UVR measurement, participants completed structured questionnaires detailing demographic information, duration of outdoor work, sun protection practices, and any reported health issues related to UV exposure. The collected data were analysed to determine the correlation between measured UVR exposure and reported health outcomes, providing insights into the risks associated with outdoor military duties. Ethical approval was obtained from relevant authorities, and informed consent was secured from all participants before data collection.

Results: The questionnaire survey was completed by 161 military outdoor workers, comprising males (n=94, 58.39%) and females (n=67, 41.62%). The age category with the most study population was 19 to 25 (n=51, 31.68%). The analysis revealed several significant relationships between sun protection behaviours and health outcomes. A strong positive correlation exists between wearing clothes that cover the arms and legs and avoiding sun exposure between 12 and 3 PM ($r = 0.530$, $p < 0.001$) and sunscreen use ($r = 0.475$, $p < 0.001$), indicating that individuals who adopt protective clothing are also more likely to engage in additional sun protection behaviours. A moderate positive correlation was found between working around reflective surfaces and blurred vision ($r = 0.217$, $p = 0.006$), highlighting potential eye health risks. A moderate positive correlation was found between working around reflective surfaces and blurred vision ($r = 0.217$, $p = 0.006$), highlighting potential eye health risks. Additionally, sunscreen use showed a weak but significant correlation with reduced eye pain ($r = 0.216$, $p = 0.006$). In terms of health outcomes, sunscreen use is significantly associated with fewer brown spots ($r = 0.426$, $p < 0.001$) and a lower incidence of sunburn ($r = 0.319$, $p < 0.001$).

Conclusion: The study highlights the significant link between occupational health risks faced by military outdoor workers and their sociodemographic characteristics. The results indicate that outdoor military workers in Lohatla face a high risk of skin cancer and other UV-related illnesses, influenced by environmental factors and personal behaviours and no direct relationship between physical activity, sociodemographic characteristics, and UV radiation exposure. Military institutions can enhance their personnel's long-term health and safety by tackling these problems through educational initiatives, youth-focused treatments, and gender-sensitive programs.

Keywords: military personnel, health effects, outdoor workers, protective measures, UVR exposure

DEDICATION

This dissertation is dedicated to the brave men and women of the South African National Defence Force (SANDF) who serve selflessly and tirelessly in challenging environments. Your commitment to duty inspires us all and highlights the importance of prioritising your health and well-being.

I also dedicate this work to my family and friends, whose unwavering support and encouragement have been my foundation. Your belief in my capabilities has fuelled my determination to explore and address the crucial issues our military personnel face.

Lastly, I dedicate this study to those who have suffered from the adverse effects of UV radiation exposure. May this research contribute to greater awareness, protection, and, ultimately, a healthier future for all those in service.

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LIST OF ABBREVIATIONS

BCC	Basal Cell Carcinoma
CDC	Centre for Disease Control
DNA	Deoxyribonucleic Acid
DTIC	Defence Technical Information Centre
DWD	Deutsche Wetterdienst
EPA	Environmental Protection Agency
LIG	Light Infantry Group
NMSC	Non-Melanoma Skin Cancer
PPE	Personal Protection Equipment
SANDF	South African National Defence Force
SPF	Sun Protection Factor
SSC	Squamous Cell Carcinoma
UPF	Ultraviolet Protection Factor
UV	Ultraviolet
UVR	Ultraviolet Radiation
WBGT	Wet Bulb Globe Temperature
WHO	World Health Organization
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom

CHAPTER 1: INTRODUCTION

1.1 Introduction

Exposure to ultraviolet (UV) radiation is a public concern, particularly among outdoor workers like military personnel who frequently work in conditions with continuous sun exposure. Lohatla in the Northern Cape region has unique climatic characteristics that increase UV exposure levels (South African Weather Service, 2023). The electromagnetic spectrum includes three different forms of ultraviolet radiation: UVA, UVB, and UVC. While UVA and UVB can penetrate the skin and cause various health problems, UVC is primarily absorbed by the Earth's atmosphere (Maverakis et al., 2010). According to Gray (2014), UVA is linked to skin ageing and long-term skin damage, while UVB causes sunburn and plays a significant role in the emergence of skin cancer. Nonetheless, given military outdoor personnel's difficulties and health hazards, assessing ultraviolet radiation (UVR) exposure is highly relevant (Lucas et al., 2019). Military troops are frequently exposed to high UVR, which can harm their health when stationed in sunny areas like Lohatla in the Northern Cape.

Exposure to sunlight is a significant risk factor for both acute and chronic health problems in military outdoor personnel, according to statistics from the Centres for Disease Control and Prevention (CDC, 2024). It is critical to recognise that UVR has a substantial correlation with the emergence of skin malignancies, including melanoma, squamous cell carcinoma (SCC), and basal cell carcinoma (BCC) (Olsen et al., 2015). Numerous epidemiological studies have repeatedly demonstrated a strong relationship between the occurrence of several health hazards, especially skin malignancies, and exposure to solar UVR (Reichrath & Nürnberg, 2009). In South Africa, the frequency of non-melanoma skin cancers (NMSC) is frighteningly high, particularly among military outdoor workers, emphasising a substantial health risk affecting a considerable proportion of the population across both genders (Samela et al., 2022).

Moreover, the primary factor that escalates the likelihood of developing NMSC, particularly SCC, is the cumulative exposure to solar UVR over time (Nkogatse et al., 2019). This pattern suggests that increased sunlight exposure correlates directly with heightened risks of developing NMSC (Peters et al., 2019), among military personnel. Research by Wright and Norval (2021) supports this by reiterating the link between extended periods of excessive UV exposure and various health hazards. Long-term UVR exposure can damage skin cells' DNA (Moehrle, 2008). If this damage is not sufficiently repaired, it can contribute to the development of several skin disorders, including skin cancer (Peters et al., 2019). Furthermore, exposure

to UVR substantially reduces the immune system's capacity to identify and eradicate malignant or aberrant cells, which may permit such cells to grow unchecked (Sharma et al., 2023). Beyond just increasing the risk of skin cancer, UVR exposure is also linked to an increased rate of skin ageing and the development of wrinkles, fine lines, and age spots (Moehrle, 2008).

Military outdoor workers at Lohatla are particularly vulnerable due to prolonged sun exposure during training and operational activities (Brundage et al., 2017, Lucas et al., 2019). Squamous Cell Carcinoma (SCC) is a type of skin cancer prevalent among outdoor workers (Wright et al., 2023). The risk increases with cumulative sun exposure, making monitoring and managing UV exposure imperative (Nkogotse et al., 2019). Although basal cell carcinoma (BCC) is often identified in military people, it nevertheless offers serious health hazards, despite being less aggressive than squamous cell carcinoma (SCC) (Olsen et al., 2015). Melanoma is the most dangerous type of skin cancer and can be lethal if not identified in time (Brundage et al., 2017), although being less frequent. The high UV exposure levels that military personnel experience put them in danger (Lucas et al., 2019). Long-term UVR exposure weakens the immune system and damages skin cells. Studies reveal that ultraviolet light can suppress the immune system (Arnold et al., 2022), making it more challenging for the body to identify and eliminate abnormal cells (Sharma et al., 2023). Consequently, this can lead to a higher incidence of skin cancers among military personnel (Brundage et al., 2017). Moreover, chronic UV exposure accelerates the skin's ageing process. Prolonged UV exposure can cause wrinkles and fine lines, which increase the breakdown of collagen and elastin fibres and lead to visible signs of ageing (Amaro-Ortiz et al., 2014).

In addition, UVR exposure has an adverse impact on the blood vessels in the skin, leading to impaired circulation and potentially causing various skin problems (Suschek et al., 2022). The weakening of vascular structures can worsen other skin issues, contributing to the overall risk of skin cancer among military outdoor workers. Exposure to UVR from the sun is one of the widespread risk factors for skin cancer development, with eye exposure influenced by numerous factors, including atmospheric conditions, environmental reflections, geographic location, and the anatomical positioning of the eye (Marro et al., 2022). It can generally be contended that the most exposed unit in the military is the Light Infantry Group (LIG) due to the extensive time they spend training in sweltering weather conditions (Brundage et al., 2017). This group is more likely to suffer from skin cancer risks compared to other military units. Conversely, personnel assigned to mechanised units experience the lowest exposure due to their sheltered environment (Helmandollar et al., 2020). Notwithstanding the use of protective uniforms, including headgear such as caps, hats, or helmets, certain body areas (e.g. the neck

and face) remain vulnerable to UV exposure among military outdoor workers (Ribas et al., 2022). The effects of UV radiation on the skin, eyes, and immune system manifest progressively over time, leading to long-term health complications (Shahzad et al., 2020). The accumulation of UV exposure can have compounding effects, necessitating ongoing monitoring and protective measures.

1.2 Problem statement

Exposure to ultraviolet (UV) radiation has long been perceived as a strong determinant that imposes significant health risks. Yet, military workers often experience extended periods of UV exposure due to the demands of their profession and its operational environments (Ribas et al., 2022). While the harmful health effects of UV radiation are well-established, there is a limited focus on the specific considerations contributing to prolonged UV exposure among military workers and the resulting health risks (Belyaev et al., 2022). Understanding these factors and risks is essential for developing targeted preventive strategies and interventions to protect military personnel from the harmful consequences of excessive UV radiation. The problems associated with exposure to UV radiation include weakening the immune system's ability to defend against illnesses, including infections and the early stages of skin cancer. This suppression increases the risk of abnormal cell growth going unnoticed and untreated (Katiyar, 2007; D'Orazio et al., 2013). Military workers exposed to both intense UV radiation and high temperatures are at an elevated risk of heat-related illnesses, such as heat exhaustion and heatstroke (Leyk et al., 2019). These conditions lead to dehydration and, in severe cases, organ failure. The increased risk of skin damage and cancer leads to sensitive anxiety, stress and concern about personal health among military workers, having an impact on their overall well-being and mental health. Extreme and extended exposure to the sun's UV rays is a key risk factor for skin cancer, making outdoor workers a high priority for skin cancer prevention efforts (Wright et al., 2023). Those in the military who work outside frequently and in high UVR situations are especially vulnerable. Solar UV radiation risks for outdoor workers are high, according to Wright & Noval (2021), mainly when UVR exposures can occur throughout the year.

The literature highlights a significant knowledge gap concerning the factors contributing to prolonged ultraviolet (UV) radiation exposure among military outdoor workers and the associated health risks (Andrady et al., 2023). While studies have established the general health implications of UV exposure, limited research delves into outdoor military workers' unique circumstances and how these factors amplify UV exposure risks. Despite these known risks, there is a concerning lack of comprehensive data specifically targeting the levels of UV

exposure among military personnel in this region. Additionally, the effectiveness of current protective measures such as sunscreen, protective clothing, and scheduled breaks has not been evaluated thoroughly.

This lack of information poses a health risk to military personnel. It affects the overall operational readiness of military units, as health issues can lead to decreased performance and increased healthcare costs. Therefore, addressing this knowledge gap is imperative to formulate effective health and safety strategies, ensuring the well-being of military personnel engaged in outdoor operations. Notwithstanding the well-known risks, little is known about UVR exposure among the military's outdoor employees in South Africa, particularly in Lohatla. This study addresses the knowledge gap by focusing on the reasons behind prolonged UV exposure among military outdoor workers. Identifying contributing factors unique to military operations offers insights that guide preventive measures. The study's adapted strategies are altered to suit outdoor military workers, ensuring the interventions' applicability and success. In the end, this research will not only supplement the understanding of UV exposure risks but also provide actionable solutions that have the potential to safeguard the health and well-being of military outdoor workers.

1.3 Aim

This study's primary aim is to evaluate the extent of exposure to ultraviolet radiation (UVR) among military outdoor workers stationed at Lohatla, Northern Cape.

1.4 Objective

To achieve the primary aim of this study, the following specific objectives were pursued:

- To assess the impact of UV radiation exposure on health outcomes among military outdoor workers at Lohatla, Northern Cape.
- To measure the environmental exposure to UV radiation among outdoor military workers at Lohatla, Northern Cape.
- To establish the correlation between UV radiation health effects, physical activities, and sociodemographic variables among Lohatla, Northern Cape military outdoor workers.

1.5 Research questions

To answer the specific objectives of the study formulated, the following research questions were formulated:

- What are the levels of ultraviolet radiation exposure among military outdoor workers at Lohatla, Northern Cape, and how effective are the current protective measures in mitigating the health risks associated with this exposure?
- How can environmental UV radiation exposure be quantified among military outdoor workers stationed at Lohatla, Northern Cape?
- What is the relationship between UV radiation health effects, physical activities, and sociodemographic variables among military outdoor workers stationed at Lohatla, Northern Cape?

1.6 Hypothesis

- H_1 : There is no significant risk of health-related effects from UV radiation exposure among military outdoor workers at Lohatla, Northern Cape.
- Alternative hypothesis (H_0): There is a significant risk of health-related effects from UV radiation exposure among military outdoor workers at Lohatla, Northern Cape.
- H_1 : UV radiation exposure to military outdoor workers stationed at Lohatla, Northern Cape, cannot be quantified by assessing environmental and personal factors.
- Alternative hypothesis (H_0): The exposure of military outdoor workers stationed at Lohatla, Northern Cape, to UV radiation can be quantified by assessing environmental and personal factors.
- H_1 : There is no relationship between UV radiation health effects, physical activities, and sociodemographic variables among military outdoor workers stationed at Lohatla, Northern Cape.
- Alternative hypothesis (H_0): There is a relationship between UV radiation health effects, physical activities, and sociodemographic variables among military outdoor workers stationed at Lohatla, Northern Cape.

1.7 Justification of the study

The necessity for this study arises from several critical factors that highlight the vulnerability of outdoor military workers to ultraviolet (UV) radiation exposure. Given the unique operational environment at Lohatla, Northern Cape, where military training and outdoor exercises are frequently conducted, it is essential to justify the significance of investigating UV exposure among these personnel. Lohatla is located in a region characterised by high solar intensity, resulting in elevated levels of UV radiation. According to the South African Weather Service, areas in the Northern Cape receive some of the highest UV index readings, often exceeding safe exposure limits (South African Weather Service, 2023). Military personnel operating in such conditions face significant risks, necessitating a thorough assessment of their UV exposure levels (Sinikumpu *et al.*, 2022). Research has consistently demonstrated a direct correlation between extensive UV exposure and adverse health outcomes, particularly skin cancers, eye damage, and immune suppression (Tang *et al.*, 2024). Understanding these health risks is crucial for military personnel, who may remain unaware of the potential long-term consequences of their occupational exposure. The study aims to fill this knowledge gap by evaluating the extent of UV exposure and its health implications.

While there is a growing body of literature on UV exposure and its health effects in various occupations, specific research on military outdoor workers in South Africa is limited, particularly at Lohatla. This study seeks to address this void by providing empirical data and insights into the experiences of military personnel, which can inform policy and protective measures tailored for this unique demographic. Incorporating findings from this study into existing occupational safety regulations is essential for improving health outcomes and reducing the risk of UV-related illnesses among military workers. With the South African Defence Force committed to the well-being of its personnel, this research can serve as a foundation for developing and implementing effective UV exposure mitigation strategies. This study's results can influence policy decisions regarding military training protocols and health guidelines. Training programs can be enhanced by highlighting the necessity for adequate protective measures to educate military personnel about safe sun practices and promote behaviours that minimise UV exposure risks.

1.8 Significance of the study

The study of ultraviolet (UV) radiation exposure among military outdoor workers at Lohatla, Northern Cape, holds significant importance, particularly for the South African National Defence Force (SANDF). By examining the specific risks associated with UV exposure within

this context, the research enhances the understanding of occupational health challenges faced by military personnel. This study contributes to the existing body of literature and has practical implications for the operational readiness and overall welfare of the SANDF. Although extensive research exists regarding UV exposure and its associated health risks, there is a notable lack of studies focusing specifically on military personnel in South Africa (Albert & Ostheimer, 2003). This study addresses this gap by providing empirical data on UV exposure levels in this unique occupational setting, enriching the literature on military health risks. Furthermore, this study sets a precedent for methodological rigour in occupational health research within military contexts by employing a quantitative method, quantitative UV measurements and questionnaire surveys. This approach has been advocated in recent literature as it allows for a comprehensive understanding of the issues (Brown & Daniels, 2021).

The findings of this study are crucial for informing SANDF policies regarding occupational health and safety. By providing concrete data on UV exposure risks, the research can guide the development of tailored health policies aimed at reducing UV-related health issues among military personnel. The SANDF is responsible for ensuring the well-being of its personnel. This study highlights the need for targeted health interventions such as training programs on UV protection and the provision of adequate protective gear. Enhanced awareness and resource allocation can significantly reduce UV-related health problems, contributing to a healthier military force (Meyer, 2020). Therefore, understanding UV exposure risks is critical not only for health, but also for maintaining operational readiness. Personnel informed and protected against UV risks are more likely to perform effectively under challenging conditions. Integrating the study's findings into operational protocols can enhance the SANDF's readiness while ensuring personnel safety (Graham, 2018). This study is essential for both academic discourse and the strategic operations of the South African National Defence Force. Addressing existing literature gaps and providing actionable recommendations contributes significantly to understanding UV exposure among military personnel. The recommendations from this research can be instrumental in shaping a safer and more effective military environment.

1.9 Layout of the dissertation

This study includes five chapters.

Chapter 1 serves as the introductory foundation for this study, encompassing the introduction of the study's title and articulating the identified problem statement. In this chapter, the primary

focus is on presenting the aim and objectives that guide the research, outlining the track of investigation and the intended outcomes.

Chapter 2 navigates through a comprehensive literature review that delves into the exposure of outdoor workers to solar ultraviolet radiation (UVR). This chapter critically examines the existing knowledge surrounding this domain, elucidating the degrees of UVR exposure's impact on the broader canvas of public health.

Chapter 3 takes a methodological stance, presenting the systematic approach undertaken to measure both personal and ambient ultraviolet radiation in the distinctive training settings within Lohatla. This chapter transparently articulates the methodology applied for these measurements and engages in a thoughtful discourse of the resultant outcomes, contextualising them within the specific military training environments.

Chapter 4 represents a pivotal junction where the health effects of ultraviolet radiation (UVR) are rigorously expounded upon. This chapter delves deep into the multifaceted aspects of UVR's impact on health, meticulously connecting the narrative to the set objectives for a cohesive exploration.

Transitioning towards the culminating phase, Chapter 5 encapsulates a synthesis of the research's findings in tandem with each stated objective. This final chapter also assembles an overarching conclusion that captures the study's journey. The discussion in Chapter 5 extends beyond mere summation, as it actively analyses the study's strengths and limitations, followed by the formulation of recommendations that will shape the path of future research endeavours in this arena. This structuring of chapters forms a cohesive narrative that engages with the research problem, aims, and objectives and navigates through the intricacies of UVR exposure's impact on outdoor workers and the broader public health domain. The culmination of each chapter contributes to the holistic understanding of the study's topic and sets the stage for meaningful contributions to the field.

1.10 Summary and transition

This chapter assessed the UV radiation exposure experienced by military personnel working outdoors and examined the health effects of this exposure.

In Chapter 2, an in-depth literature review is conducted to showcase a comprehensive grasp of the impacts of UV radiation on military personnel working outdoors. Subsequently, the study will elucidate the robustness of the meticulous evaluation undertaken within this research.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Exposure to ultraviolet radiation (UVR) increases the chance of developing cataracts, sunburn, early ageing, and skin cancer, among other serious health problems. According to studies, skin malignancies have been linked to exposure to solar UVR (Raimondi et al., 2009; Reichrath & Nürnberg, 2009). Long-term sun exposure has been associated with several health risks, including DNA damage, immune system weakness, premature skin ageing, reduced skin vascular function, and an elevated risk of skin cancer (Wolf et al., 2020). The increased risk of skin cancer, especially the more severe melanoma and non-melanoma skin cancers, is one of the most worrisome effects. People can lower the dangers of UVR exposure and protect their long-term health by practising proactive sun protection measures (Christoph et al., 2016).

Ultraviolet (UV) light is a type of electromagnetic radiation produced by nuclear fusion events that occur in the Sun's core. These reactions emit energy in the form of photons, which move across a broad spectrum, including UV light, which has wavelengths between roughly 10 and 400 nm, when hydrogen nuclei are fused to make helium (Hawkes, 2023). This spectrum is further separated into three groups: UVA (320–400 nm), UVB (280–320 nm), and UVC (100–280 nm), according to Hiller et al. (2022). Distinct physical traits and interactions with matter set each of these groups apart. UV light is necessary for a lot of photochemical processes in chemistry. When electrons are stimulated by UV photon energy, chemical bonds can break and then reform (Pflug, 2021). This theory explains why UV light can damage bacteria's DNA and cause them to become dormant, which is why it is so effective at disinfecting (WHO, 2020). Moreover, UV light is necessary for ozone production in the Earth's stratosphere. This method demonstrates how physical and chemical processes related to UV light are interrelated. According to Luo et al. (2021), UV-C photons split oxygen molecules (O_2) into individual atoms, which can then react with other oxygen molecules to generate ozone (O_3). The health impact of UV exposure is emphasised by data such as **Figure 2.1**, which illustrates melanoma and keratinocyte carcinoma disability-adjusted life years per 100,000 population by Global Burden of Disease world regions in 2017 (Urban et al., 2021). See how UV light is created and penetrates the skin in the graph below.

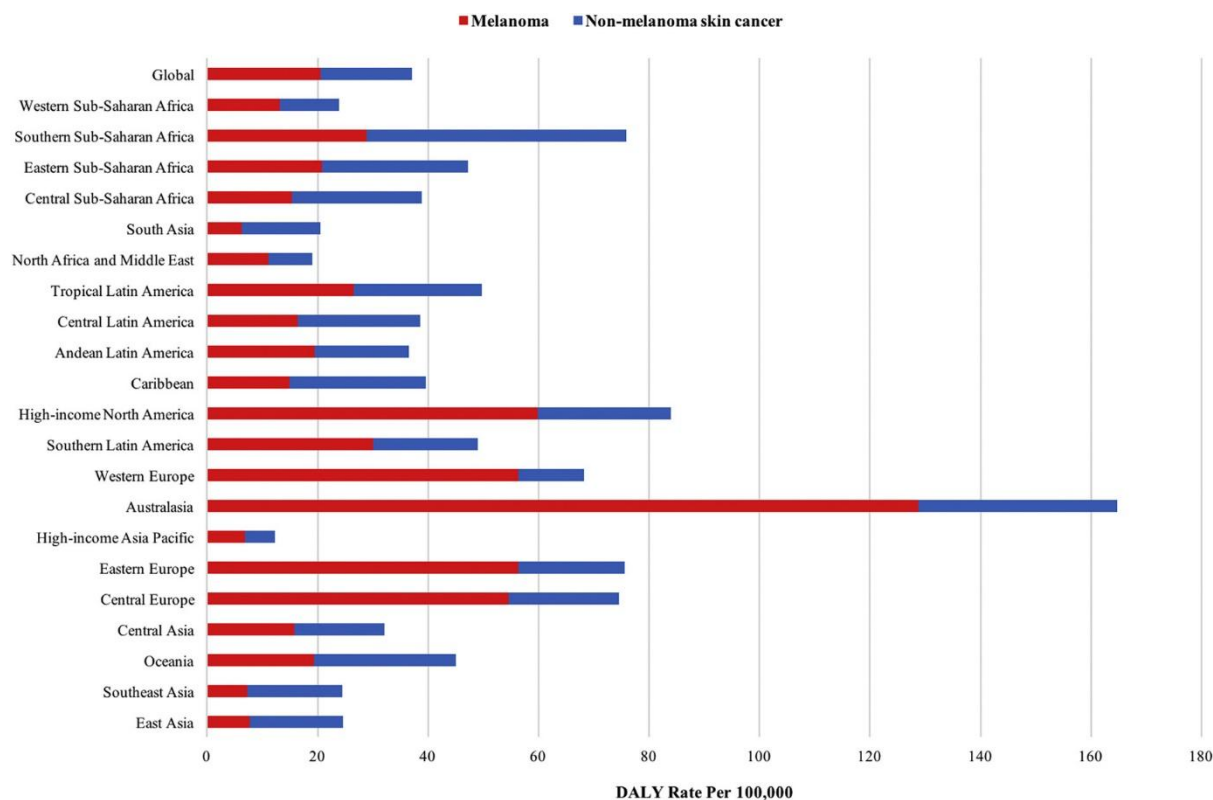


Figure 2.1: Melanoma and keratinocyte carcinoma disability-adjusted life years per 100,000 population by Global Burden of Disease world regions in 2017 (Urban et al., 2021)

The uncontrolled proliferation of abnormal cells within the body is one of the several intricate molecular processes contributing to cancer development. This process often begins with genetic mutations, which can be caused by several factors, including exposure to carcinogens (such as tobacco smoke and UV radiation), viral infections, and inherited genetic predispositions (Hanahan & Weinberg, 2011). Regular biological functions are hampered by these mutations, particularly those involving the regulatory systems that govern cell growth and division. As a result, cells may evade apoptosis, the process of controlled cell death that often eliminates damaged or faulty cells, allowing them to increase unchecked. Malignant (cancerous) or benign (non-cancerous) tumours may occur as a result of uncontrolled growth (Hanahan & Weinberg, 2011). Malignant tumours can penetrate the surrounding tissues and metastasise. Because of the complex interconnections between genetic, environmental and lifestyle factors that contribute to the disease's variability, modern medicine faces enormous problems in the prevention, detection and treatment of cancer (Hanahan & Weinberg, 2011).

Controlling the development of cancer requires a multimodal strategy that includes both prevention and therapy methods. Promoting healthy lifestyle choices and lowering exposure to known carcinogens are the two main objectives of preventative interventions. For instance, quitting tobacco usage significantly reduces the risk of developing malignancies like lung and oral cancer, because tobacco smoke contains several carcinogenic compounds (WHO, 2021). Additionally, by promoting sunscreen and protective clothing, public health programs that

promote sun safety can lower the risks associated with UV exposure and the incidence of skin cancer (AAD, 2022).

Numerous therapeutic options exist for treating advanced cancer. These include surgery, chemotherapy, radiation therapy and targeted therapies that target only cancer cells, while sparing healthy tissues. Some cancer types may be managed or even cured thanks to technological advancements in immunotherapy, which fights cancer by utilising the body's immune system (Deng et al., 2016). The ongoing study of tumour genetic and molecular profiling, which allows for individualised treatment plans that maximise benefits and reduce side effects, emphasises the need for tailored approaches in cancer care. Military outdoor personnel are especially susceptible to UVR-related health problems since they are regularly exposed to sunlight while training and conducting operations.

One of the primary and most common risk factors for cataracts, a common eye condition marked by clouding the eye's natural lens and impairing vision, is exposure to sun ultraviolet radiation (UVR) (Marro et al., 2022). Because the eyes are exposed to sunshine, they are especially vulnerable to UVR damage. The amount of UVR exposure to the eyes depends on several factors. The amount of UVR that reaches the Earth's surface depends on the atmosphere; on sunny, clear days, the amount is more significant (Yam & Kwok, 2014). Furthermore, surfaces like water, sand and snow can reflect UVR, increasing exposure, particularly outdoors (Marro et al., 2022). Geographical location is critical, because higher elevations and areas nearer the equator generally have greater UVR levels (Bertaux et al., 2016). Finally, exposure can be influenced by the eye's anatomical position; those with lighter-coloured irises or larger pupils are more vulnerable to UVR (Yam & Kwok, 2014).

Regular outdoor workers are particularly vulnerable to excessive sun exposure and, as a result, are more likely to experience the adverse effects of ultraviolet radiation (UVR). Persons who work outdoors, including construction workers, agricultural labourers, and military people, are more susceptible to these health risks since they are frequently exposed to UVR for prolonged periods. Reinau et al. (2013) indicate that high sun-intensity environments, such as those with extremely high ambient temperatures and high ultraviolet (UV) index values, are frequently the sites of military activities (Wolf et al., 2020). Particularly in arid or tropical areas, military personnel participating in outdoor operations, training and activities may be exposed to direct sunlight for extended periods (Buller et al., 2011). The effects of UVR can be exacerbated by high ambient temperatures, raising the risk of heat-related disorders such as heat exhaustion and heatstroke (Wolf et al., 2020). According to a study, fewer than 30% of the soldiers surveyed said they regularly used sunscreen, while a sizable majority of military personnel deployed to Iraq and Afghanistan reported that their skin was uncovered about 70%

during deployment (Powers et al., 2015). Sunscreens are crucial for protecting the skin from the harmful effects of ultraviolet (UV) radiation. Sunscreen effectiveness is often measured by the Sun Protection Factor (SPF), which indicates the level of protection the product provides against UVB radiation. However, a range of coolants are also included in sunscreen formulations to enhance user experience and application comfort (Gabros et al., 2023).

Coolants are substances added to sunscreen compositions to give users a cooling feeling right after application. They can soothe the skin and reduce the hot sensation caused by sun exposure (Berkey et al., 2019). Common coolants include:

- Menthol: Offers a calming effect and may reduce the discomfort associated with sunburn (Kim et al., 2023).
- Peppermint Oil: Besides having a revitalising aroma, this all-natural coolant has relaxing properties for the skin (Resende et al., 2022).
- Camphor: renowned for its cooling and relaxing properties, it can enhance the sensory experience of applying sunscreen (Kim et al., 2023). These coolants are particularly helpful for formulations used in outdoor activities because they can increase comfort with prolonged sun exposure.

The amount of UVB protection a sunscreen offers is indicated by its SPF rating. A higher SPF rating indicates greater protection. However, it is crucial to comprehend how SPF translates into effectiveness:

- SPF ratings indicate the level of UVB protection provided by sunscreen. A higher SPF rating indicates greater protection. However, it is crucial to understand how SPF translates into efficacy.
- About 93% of UVB rays are protected by SPF 15. According to the AAD (2023), this level is generally recommended for daily use, especially for those with darker skin tones or without sun exposure.
- About 97% of UVB rays are blocked by SPF 30, which is considered adequate for most outdoor activities. This protection is recommended for people with fair skin or who may spend too much time outside (Dale et al., 2012).
- SPF 50: Offers over 98% protection against UVB rays, making it ideal for individuals with very fair skin, or those participating in high-exposure activities like hiking or beach excursions (AAD, 2023).

Although SPF is a crucial protection parameter, other factors should also be considered, such as water resistance, UVA ray protection from broad-spectrum formulations, and suitable application techniques. Research shows that many people do not use enough sunscreen, which can significantly reduce the product's ability to protect. The best protection is achieved by liberally applying a broad-spectrum sunscreen with at least SPF 30 and reapplying it every two hours, particularly after swimming or perspiring (WHO, 2002).

2.2 Narrow overview of Lohatla

It is necessary to create a cohesive understanding of the study area at Lohatla, a controversial location in the Northern Cape with a history of removal. When two black communities, the Maremane and Gatlhose, were forcibly moved in 1977 to make space for the South African National Defence Force (SANDF) to build the second-largest combat school in the world, it turned into a contentious battleground (Mckenzie, 2000). The Khosis, on the other hand, opposed their expulsion from the region. These uprooted communities have gradually claimed portions of the combat school's vast 135 000-hectare property.

The South African National Defence Force (SANDF) still enacts extensive war games on the site, simulating battles against a fictional opponent, despite the communities' attempts to recapture some areas of the battle school (Mckenzie, 2000). The problems caused by military contamination are best illustrated by the circumstances at both Lohatla and Riemvasmaak. There have been multiple reports of injuries to locals, which are thought to be the result of unexploded bombs left behind from previous military operations. According to Mckenzie (2000), worries about military contamination are heightened by the employment of landmines as offensive weapons in southern Africa. The complicated problems of historical displacement, land rights, and the environmental effects of military operations in the area are all reflected in the circumstances at Lohatla.

2.3 Literature search strategy

It was essential to carry out a methodical literature search technique to evaluate UVR exposure to outdoor military workers in full. This required a systematic process of finding and examining pertinent research, reports, and academic papers that offer in-depth details on UV radiation exposure. It was crucial to specify precisely which components of UVR exposure in the military environment were necessary, such as measurement methods, health consequences, preventive measures, or the analysis of certain military branches. Using terms like 'ultraviolet radiation exposure', 'military personnel', 'outdoor workers', and similar

expressions, a list of relevant keywords and search queries was thus created. These terms were used to build search queries in specialised military databases like the Defence Technical Information Centre (DTIC) and databases search engines like Pubmed and Google Scholar. Searches were refined using Boolean operators like AND, OR, and NOT, which combined keywords to get targeted results.

Moreover, employing truncation and synonyms ensured that variations of terms were captured. In addition to conventional academic outlets, exploring reports, theses and conference proceedings was crucial, as these sources provided valuable perspectives and findings. Continuously refreshing the search and seeking advice from librarians to fine-tune the strategy was vital for guaranteeing a comprehensive and current evaluation of UVR exposure among military outdoor workers. This extensive method not only facilitated the collection of a wide range of sources, but also ensured the inclusion of the most relevant and up-to-date research in the assessment.

2.4 Level of UV exposure on outdoor workers

Both immediately and over time, military personnel's health and performance were significantly affected by exposure to outdoor ultraviolet (UV) radiation. To give a thorough understanding, Ribas et al. (2022) back up this idea by highlighting that extended exposure to UVR from the sun may cause several harmful health effects, including sunburn, skin ageing, cataracts, and an increased risk of skin cancer. Because military personnel often spend long periods outside, evaluating and controlling their UVR exposure has become crucial (Grøntoft & Marincas, 2018). South Africa is situated between 22 °S and 35 °S, which are the midlatitudes. Its terrain comprises coastal plains and the Highveld, a large central plateau inland at about 1 200 metres (Moda et al., 2019). Because of the country's high altitude and the regular occurrence of high-pressure systems over the plateau, the skies are comparatively clear all year long. Consequently, this combination increases ambient solar ultraviolet radiation (UVR) levels.

Several pieces of equipment were available to measure outdoor workers' exposure to ambient ultraviolet (UV) radiation. These devices are handheld radiometers, dosimeters and UV index meters (Glanz et al., 2007). Handheld radiometers and dosimeters, which can measure UV radiation intensity in real-time, were used to assess the UV radiation exposure of outdoor workers during various work tasks. Due to their portability and ease of use, these devices were ideal for field measurements (Glanz et al., 2007). The UV index meter is another device that may measure exposure to ambient UV radiation. These devices monitor the UV index, which

shows the amount of UV radiation and the potential harm of sun exposure (Cherrie et al., 2021). The values on the index range from 0 to 100. Skin and eye damage risk increases with a higher UV index, and damage starts sooner (Cherrie et al., 2021). Several factors, such as device kind, measurement precision and user-friendliness, affect these tools' effectiveness and efficiency. Depending on the specific needs of the workplace and the types of tasks that outdoor workers do, it was essential to select the appropriate instrument for the job (Glanz et al., 2007).

To provide a more thorough explanation, Rother et al. (2019) describe how several environmental conditions affect the amount of solar UVR that South African outdoor workers are exposed to. These variables include latitude, altitude, cloud cover, solar zenith angle, stratospheric ozone, and albedo. The type of work activity, the amount of time spent outside, and the availability of physical sun protection infrastructure, such as shade, were also critical occupational determinants. The intricacy of the variables influencing outdoor workers' exposure to solar UVR in the area was clarified by highlighting these elements. Military troops exposed to high UV levels without adequate protection run the danger of being sunburnt, according to Woo et al. (2022). This ailment might be excruciating and could impair their capacity to perform their jobs efficiently, ultimately leading to decreased output. According to Woo et al. (2022), military personnel must limit excessive UV exposure and ensure they have enough protection to prevent sunburn and its negative consequences on their operational capabilities, given the implications for performance.

The global climate both influences and is influenced by the sun's ultraviolet (UV) radiation (Filonchik et al. 2024). Because of a decrease in stratospheric ozone, more UVB radiation, a more vital type of UV light with a higher frequency, can reach the Earth's surface and harm DNA in plants and animals (SERC, 2023). In contrast, increases in cloud cover, pollution, dust, smoke from wildfires, and other airborne and aquatic particles associated with climate change decrease the penetration of UV rays (WHO 2002). There exists a wealth of data demonstrating the impact of UV radiation on human health about climate change. Although sunburn and tanning are the best-known adverse health effects of excessive UV exposure, prolonged exposure to UV radiation may also result in degenerative changes in blood vessels, fibrous tissues, and cells, which over time may lead to non-melanoma skin cancer (Wolf et al., 2020). Cataracts and other eye disorders that cause a large portion of the world's visual impairment are exacerbated by prolonged exposure to UV radiation (Wolf et al., 2020; Ribas et al., 2022).

People of all races and ethnicities are vulnerable to the harmful effects of excessive sun exposure, according to Torrence (2017). Even if every soldier is susceptible to some ailments, their skin types will greatly influence the degree and rate of sunburn. The Food and Drug

Administration (FDA) uses a scale from 1 to 6 to categorise skin types. Fair-skinned soldiers with lower skin types (1 and 2) are more likely to become sunburnt quickly and severely (Delgado Ratto, 2019). On the other hand, although they might still get sunburnt, troops with darker skin kinds (5 and 6) do not typically burn as quickly as those with lower skin types (Delgado Ratto, 2019). An investigation by Ray et al. (2020) discovered a standard for protective clothing that established the ultraviolet protection factor (UPF), a crucial measure for assessing clothing's ability to block harmful UV rays. The remarkable potential of this standard to provide adequate protection against UV radiation has been acknowledged. It was essential to comprehend the connection between skin type, skin colour, sunburn susceptibility, and tanning capacity to evaluate people's risk of UV exposure and create suitable sun safety precautions. The many skin kinds and the traits that go with them are listed in Table 2.1:

Table 2.1: Skin types and their responses to sun exposure (Ward et al., 2017)

Skin Type	Skin Colour	Sunburn	Tanning Ability
I	Very fair	It always burns, never tans	N/A
II	Fair	Burns easily, tans poorly	Minimal
III	Medium	Burns moderately, tans gradually	Average
IV	Olive	Burns minimally, tans easily	Easily
V	Brown	Rarely burns, tans profusely	Very easily
VI	Black	Never burns, always tans	N/A

Raising awareness of the need for sun protection specific to each skin type that is directly linked to the risks of UV radiation exposure was made possible by this classification (Heckman et al., 2019). According to Lyles (2018), it is well known that military personnel are exposed to high amounts of ultraviolet radiation (UVR), mainly when they are deployed. Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF) saw the deployment of more than 3 million troops in Afghanistan and Iraq, respectively, between 2001 and 2014 (Begaj & Schaal, 2018). Due to their location in somewhat tropical latitudes, these harsh deployed environments provided intense UVR exposure with slight seasonal fluctuation. Thus, this increased exposure might have increased military personnel's risk of developing melanoma (Patel et al., 2022). According to Riemenschneider et al. (2018), the existence of such conditions in these deployed situations puts military personnel at a higher risk of experiencing detrimental health impacts from UVR exposure.

According to Ribas et al. (2022), excessive sun exposure has been connected to several health risks, such as immunological suppression, DNA damage, premature skin ageing, skin vascular malfunction, and skin cancer. Those who frequently exercise outside or participate in competitive sports are especially vulnerable to these harmful UVR effects. Similarly, military personnel and other tactical athletes are more likely to experience these potentially detrimental

effects because they frequently spend long periods outside under conditions with high UVR levels (Wolf et al., 2020). Thus, it was essential to understand the effects of extended and recurrent UVR exposure and the common sun-safety beliefs and practices among these populations (Sliney & Stuck, 2021). Acknowledging and addressing these factors may be essential to reduce the health concerns associated with UVR exposure in outdoor workers. Ray et al. (2020) conducted a study to find a solution that sheds further light on this issue. The remarkable potential of this standard to provide efficient protection against UV radiation has been acknowledged.

According to Kimlin et al. (2019), one of the main risk factors for melanoma development is the high levels of solar ultraviolet radiation (UVR) that active-duty members of the U.S. military are exposed. This exposure is caused by spending long periods performing outdoor service-based activities, often more than six hours daily under bright conditions (Kimlin et al., 2019). Additionally, the researchers discovered that active military people have a 62% higher risk of melanoma than the overall American population. The incidence of melanoma is the highest among fixed-wing pilot crew members across all armed services. Their occupational exposure to increased amounts of cosmic and UV radiation when flying at higher altitudes is probably the cause (Knezevic 2019). Additional UVR reflectance acquired during flights over sandy deserts, snowfields, or heavy cloud levels could increase their risk.

According to a study on skin cancer in military personnel, their sporadic deployments to areas with high UV radiation exposure may put them at higher risk than those in vocations that need everyday contact with the sun (Wisco et al., 2018). For example, academics contend that personnel frequently experienced numerous deployments during Operation Enduring Freedom and Operation Iraqi Freedom, with typical deployment durations varying from 9.4 months for the Air Force to 4.5 months for the Army (Wisco et al., 2018). The frequency and severity of UV exposure during these deployments may have raised the deployed service personnel's risk of melanoma or non-melanoma skin cancer. Additionally, Rother et al. (2019) discovered that people who enlist in the military from places with a low annualised UV index have a lower risk of stress fractures than those from areas with high UV intensity. This suggests that there might be a connection between military personnel's UV exposure levels and particular health effects.

According to Wolf et al. (2020), a study on skin cancer in military personnel found that service members are more at risk since they are frequently deployed to areas with high UV radiation exposure. For example, personnel often underwent numerous deployments during Operation Enduring Freedom and Operation Iraqi Freedom, with an average duration of 6 months for the Army and 10 months for the Air Force (Riemenschneider et al., 2018). During these

deployments, deployed service members were at a much higher risk of acquiring melanoma or non-melanoma skin cancer due to the intensity and repetitive nature of UV exposure. Additionally, Gall et al. (2021) found that people enlisting in the military from regions with low annualised UV index have a lower risk of stress fractures than those with high UV intensity. This research suggests a possible link between military personnel's UV exposure levels and particular health effects.

According to Ribas et al. (2022), the level of UV exposure encountered by Spanish Navy sailors varies according to their rank and duties. People who work in vocations that require a lot of sun exposure are especially vulnerable to the adverse effects of UV radiation. The military stands out among these groups because its members are frequently exposed to the sun for prolonged periods, particularly during manoeuvres, where exposure could last all or most of the day. According to Buhr et al. (2022), these manoeuvres might occur in areas with intense solar radiation, including the sunbelt region between 35 °S and 35°N, which could expose soldiers to higher UV index values. Veterans have a higher risk of skin cancer than civilians, according to studies conducted in the US military (National Academies of Sciences & Medicine, 2018). The body is exposed to increased irradiance at higher elevations; for every 1 000 metres of height, UV radiation levels increase by roughly 15% (National Academies of Sciences & Medicine, 2018), this being the reason for the elevated risk.

Gall et al. (2021) state that most Spanish Navy units mainly operate abroad, especially during training and instructional times. According to researchers, students in these units are subjected to a demanding training schedule that includes intense summer heat and sunlight and severe winter circumstances at high elevations, where UV radiation is even more powerful. Marine Corps personnel also experience high amounts of sea-reflected sun radiation (Wisco et al., 2018). Additionally, according to Coups et al. (2021), similar behaviours frequently occur in areas of the world close to the Equator, including sections of Africa or the Middle East, where the effects of UV light are noticeably more noticeable. Because of their closeness to the Equator, these regions are more vulnerable to UV radiation, which raises the possibility of health and safety hazards for naval personnel.

Personal UVR dosimetry was used to quantify outdoor workers' and athletes' UVR exposure levels. Ski instructors, triathletes and professional cyclists are exposed to UVR dosages as high as 6.9–9.7 MED, 8.1 MED, and 17.2 MED, respectively (Wolf et al., 2020). Marathon runners and alpine ski instructors are exposed to UVR levels beyond the International Commission on Non-Ionising Radiation Protection's (ICNIRP) guidelines (Snyder et al., 2020). Runners, tennis players and hikers also experience high levels of UV radiation in the summer and autumn. These people often exceed the ICNIRP's recommended limit by up to eight times,

reaching the UVR dosage exposure limit in less than 20 minutes (Snyder et al., 2020). Scholars reviewed outdoor workers' sun exposure and protection practices and found that they were largely unsuccessful. Men are more likely to use caps and protective gear, while women are more likely to apply sunscreen. In South Africa, 23% of farm workers never wear a hat, and 80% never wear sunglasses, with peak caps preferred over wide-brimmed hats. Forestry workers use hats and other materials in the Western Cape to shield themselves from the sun (Wright & Norval, 2021).

Several factors, such as the time of day, location, altitude, and weather, influence the strength of UV radiation. The UV Index, which offers information on UV radiation levels and possible health concerns to people, is one of several indices often used to evaluate UV radiation levels (EPA, 2010). The human body responds differently to different degrees of UV light exposure. Low levels of UV light exposure are generally seen as safe and, in some circumstances, even advantageous to health, such as when the skin produces vitamin D. On the other hand, an increased risk of skin cancer, sunburn, skin damage and accelerated ageing are among the adverse health effects of prolonged or excessive exposure to high UV radiation levels (WHO, 2022). To protect their skin and general health, people need to be aware of how much UV radiation they are exposing themselves to and take the appropriate precautions. This includes minimising outdoor activities during the hottest times of the day, using sunscreen, wearing protective clothes and eyewear, and looking for shade during periods of high sun intensity (EPA, 2010; WHO, 2022).

The UV Index is a statistic used to measure UV radiation levels and the possible dangers of sun exposure. Larger values of the UVI index, which range from zero to one hundred, indicate a more significant risk of damage to the skin and eyes and a quicker onset of harm. Table 2.2 below lists the suggested courses of action for different UV index levels (WHO, 2022). The UV Index proved helpful in estimating the possible damage from ultraviolet (UV) radiation and choosing the best sun protection strategies.

Table 2 2: UV index exposure categories and corresponding sun protection needs (Twilley et al., 2018)

UV Index	Exposure Category	Sun Protection Needed
0	Minimal	No protection required
1–2	Low	No protection is required; being outside is safe
3–5	Moderate	Protection is required; a shirt, sunscreen, and sunglasses are recommended when outside.
6–7	High	Protection is required. During midday hours, staying in the shade is advised. A shirt, sunscreen, a hat, and sunglasses are recommended in the sunshine.

UV Index	Exposure Category	Sun Protection Needed
8–10	Very High	Extra protection is required; staying inside is recommended between 11:00 am and 16:00. Even in the shade, a long-sleeve shirt, long trousers, sunscreen, a wide-brimmed hat, and sunglasses are recommended during those hours.
11+	Extreme	Extra protection is required. It is recommended that you stay indoors between 11:00 and 16:00 and seek shade beyond those hours. Even in the shade, a long-sleeve shirt, long trousers, sunscreen, a wide-brimmed hat, and sunglasses are essential.

Understanding the UV Index is crucial for implementing effective sun-protection strategies, particularly for vulnerable populations such as outdoor workers and military personnel (WHO et al., 2002; DWD, 2015).

2.5 Health effects related to UVR exposure

De Jager et al. (2017) state that one aspect of sunlight crucial to numerous biological processes is ultraviolet radiation or UVR. As a result, employees who spend much time outside in the sun frequently experience severe, immediate health effects. These repercussions include mental health problems and illnesses brought on by the heat. The development of symptoms such as weariness, heat exhaustion, sunburn, photokeratitis, skin cancer, cataracts, immunological suppression, and disorientation is an expected outcome of extended exposure to UV radiation. These conditions could severely compromise a person's mental health and physical abilities.

For example, in jobs where physical labour is commonly needed, such as construction or agriculture, dizziness may hinder coordination and raise the risk of workplace accidents (Rikhotso et al., 2022).

Additionally, there are notable psychological repercussions from working in high UV environments. According to studies, outdoor workers who spend a whole day outside may have higher levels of stress and anxiety, which could result in illnesses like sun-related anxiety disorder. According to Ioannou et al. (2021), job happiness and productivity may suffer due to this psychological pressure. When outdoor workers struggle with these health issues, their morale and emotional health decline, affecting their performance. Because businesses frequently see more absenteeism and decreased productivity, the National Institute for Occupational Safety and Health (2022) emphasises the vital need for sun safety precautions and routine health examinations for employees working in outdoor locations. These hazards

could be reduced by implementing efficient preventative measures, guaranteeing a safer and healthier workforce.

2.5.1 Acute health effects

According to Panich et al. (2016), sunburn is one of the most common and immediate effects of UVR exposure. Excessive exposure to ultraviolet radiation (UVR) from the sun causes sunburn. Even while sunlight is necessary for many biological functions, prolonged or severe UVR exposure causes sunburn and painful skin damage. According to Pendlebury et al. (2023), military troops exposed to strong sunlight for prolonged periods during operations or training sessions are more likely to have sunburn, which results in severe skin pain, inflammation, and swelling. Information shows that blisters and difficulty doing daily tasks could result from severe sunburn (MacKie, 2000). According to Suman and Suman (2019), sunburn happens when the skin is exposed to UVR, especially UVB rays, which pierce the skin's outer layer and damage skin cell DNA while inducing an inflammatory response in military outdoor workers. Additionally, Suman and Suman (2019) found that UVR exposure affects the cornea of the eyes, resulting in photokeratitis, also referred to as snow blindness. As a result, military outdoor workers are more susceptible to this excruciating illness, which causes temporary vision loss and eye discomfort, especially those working at higher elevations or close to reflective materials like snow or sand. Excisional repair of DNA may reverse some damage, but the reparative mechanisms are overwhelmed when ultraviolet radiation exposure is excessive. This allows the progression of mutagenesis, immune suppression, and clonal cell expansion, thus promoting tumour formation. This process is briefly shown in **Figure 2.2**, which provides a schematic illustration of the multi-step process of photocarcinogenesis, highlighting how skin exposure to ultraviolet radiation damages DNA by forming pyrimidine dimers and reactive oxygen species (Parker, 2020).

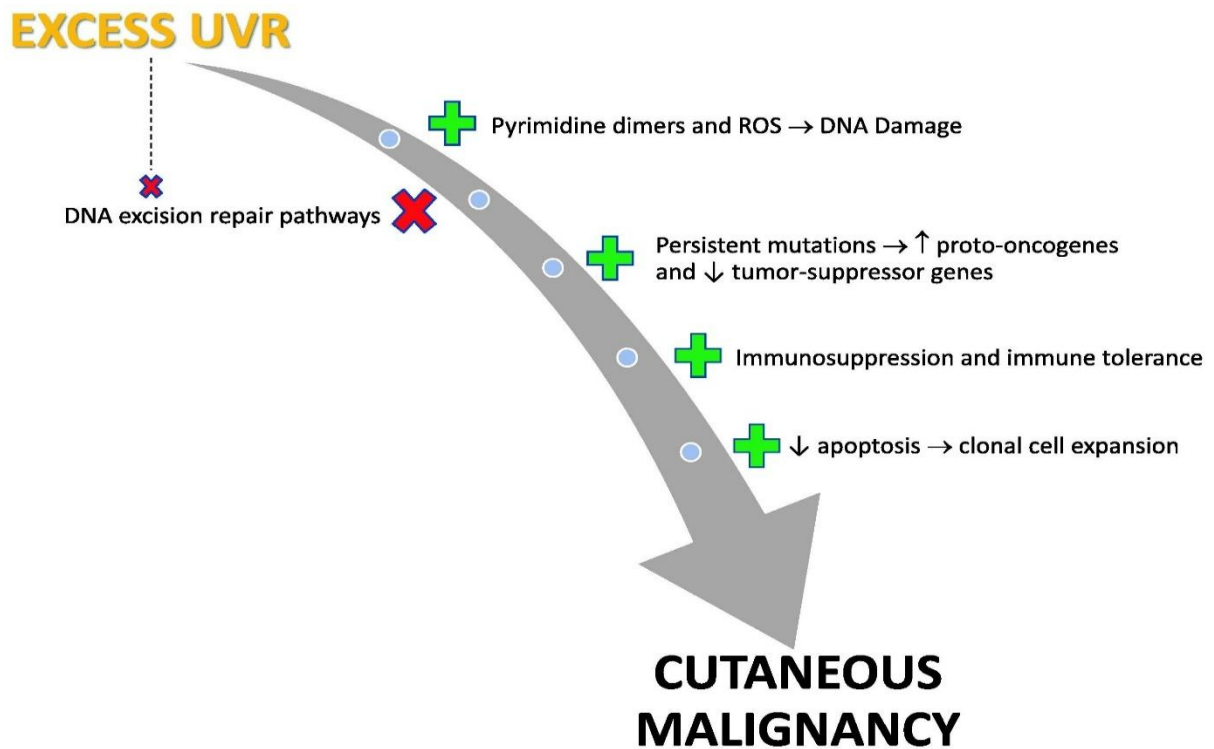


Figure 2.2: Schematic illustration of the multi-step process of photocarcinogenesis (Parker, 2020). Skin exposure to ultraviolet radiation damages DNA by forming pyrimidine dimers and reactive oxygen species

According to a study by Korzeniewski (2020), exposure to UVR induces immediate ocular irritation, which results in discomfort, profuse weeping, and red, itchy eyes. Korzeniewski (2020) goes one step further and discloses that acute UVR exposure causes immediate skin damage, including age spots, fine lines, and wrinkles. However, extended exposure to UVR, especially in hot climates, increases the risk of heat-related disorders such as heatstroke and exhaustion. James et al. (2011) state that military outdoor workers are susceptible to infections. Wound healing is hampered by photosensitivity reactions, characterised by rashes or hives on the skin following UVR exposure. The types of ultraviolet (UV) radiation and their varying degrees of skin penetration that contribute to these effects are illustrated in **Figure 2.3**, providing a clear illustration of how different UV wavelengths interact with skin layers (Watson et al., 2016).

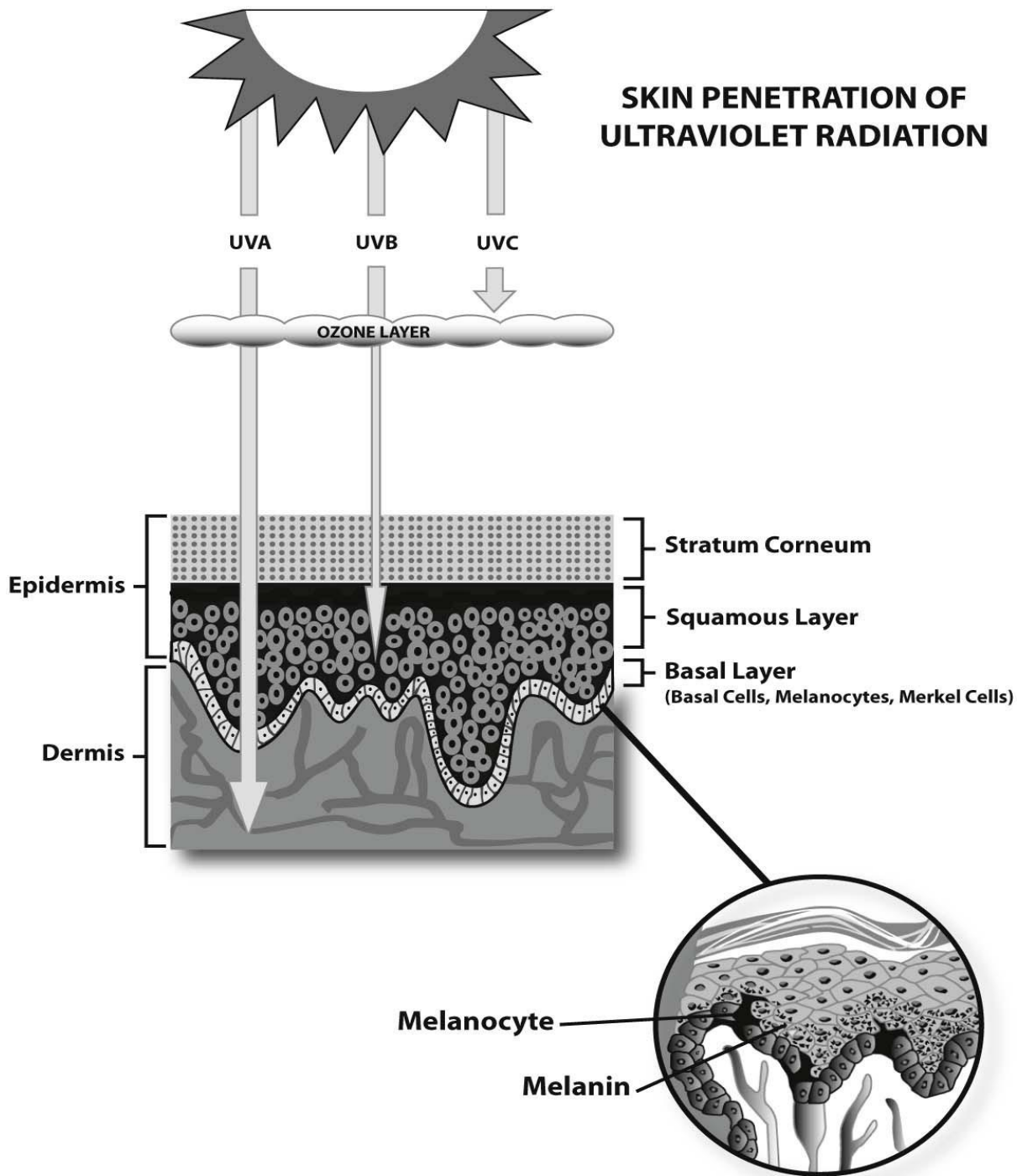


Figure 2.3: Types of ultraviolet (UV) radiation and skin penetration (Watson et al. 2016)

2.5.2 Severe health effects

Melanoma, squamous cell carcinoma, and basal cell carcinoma are among the skin cancers for which prolonged exposure to UVR is a substantial risk factor (MacKie, 2006). Over time, military personnel's chances of developing skin cancer increase due to their frequent exposure to hostile conditions and high sunshine. Long-term UVR exposure has been linked to cataract development, a disorder in which the eye's lens gets cloudy and impairs vision (Lee et al.,

2011). Therefore, it is commonly accepted that military outdoor personnel exposed to UVR without proper eye protection are more likely to get cataracts. Even though too much UVR exposure can weaken the immune system, Hart and Gorman (2013) found that UVR is essential for the synthesis of vitamin D. Because UVR exposure is thought to suppress the immune system, increasing the risk of infections and hampering wound healing, Hart and Gorman (2013) also found that military outdoor workers who are exposed to high levels of UVR during training and deployments continue to be at the highest risk of immune system compromise. It might be suggested that UVR exposure can directly influence immune cells, such as t-cells and macrophages, which are essential for protecting the body against infections, as there is still no reason to doubt that exposure to UVR impairs their general health and operational readiness.

Furthermore, the research by Bernard et al. (2019) shows that UVR weakens immune responses by causing the release of immunosuppressive substances and changing how these cells function. The balance of cytokines and signalling molecules directing the immune response is upset by UVR exposure, according to several types of literature. This imbalance makes it more difficult to fight infections successfully. Since weakened immune responses impair the body's capacity to contain and eradicate viruses, it can generally be argued that UVR-induced immune suppression can increase military outdoor workers' susceptibility to viral infections like the flu and the common cold, potentially resulting in complications and prolonged illness.

According to Lucas et al. (2014), military personnel exposed to UVR are more likely to get skin and respiratory infections because a weakened immune system may be unable to fight off bacterial infections. Athlete's foot and other fungal diseases can flourish in compromised immune systems, which are more prevalent in those exposed to ultraviolet radiation (UVR), according to Lucas et al. (2014). However, by inducing the inflammatory response, the immune system is essential for the early phases of wound healing. According to Franco et al. (2022), immunological suppression brought on by UVR slows down the inflammatory process, which results in a delayed rate of wound healing. Further impeding wound healing is UVR exposure, which inhibits the growth of fibroblasts and other cells necessary for tissue regeneration and repair. Franco et al. (2022) go one step further and show that immune suppression compromises the body's natural defences, making wounds susceptible to infection. Infections can cause more severe problems and slow down the healing process.

According to Revaiah et al. (2020), heat-related disorders such as heat exhaustion and heat stroke are caused by a combination of UVR exposure and high temperatures, particularly during military training or deployments in hot climates. If these illnesses are not addressed

right away, they may become fatal. Consequently, military personnel's immune systems and wound healing can be affected significantly by UVR exposure. According to Gancitano and Reiter (2022), immune suppression makes military troops more vulnerable to bacterial and viral illnesses, jeopardising their general health and operational preparedness. Implementing preventive measures and promoting sun protection can help military organisations to protect the health and well-being of their personnel, ensuring optimal performance and readiness during training and deployments. This is because impaired wound healing can prolong recovery time and lead to potential health complications, according to various studies. These interconnected factors, UVR exposure, health implications, preventative measures, and the unique vulnerabilities of military outdoor workers, are summarised in the conceptual framework illustrated in **Figure 2.4**, providing a holistic overview of the dynamics at play.

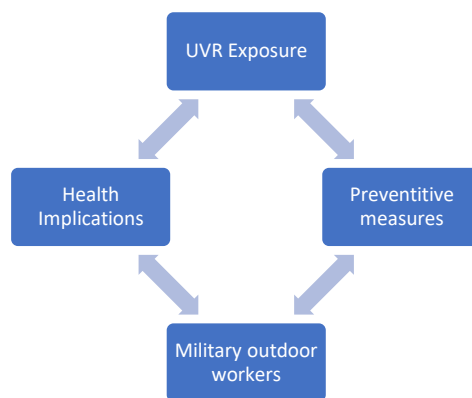


Figure 2.4: Conceptual framework assessing ultraviolet radiation (UVR) exposure among military outdoor workers

2.6 Conclusion

It can generally be summed up that UVR exposure poses significantly acute and severe health implications among military outdoor workers, as these play an essential role in promoting sunburn, photokeratitis, skin cancer, cataracts, immune suppression, and heat-related illnesses to be prevalent. However, it remains imperative to protect the well-being of military personnel through implementing preventive measures such as education, proper PPE, sunscreen use, shaded rest breaks, eye protection, and hydration. Therefore, by taking these proactive steps, military organisations can promote the health and readiness of their outdoor personnel while carrying out their essential duties.

2.7 Summary and transition

In conclusion, it is generally accepted that excessive exposure to UV radiation seriously affects one's health. UV-B radiation is the most dangerous type of UV radiation, as it can result in

sunburn, premature skin ageing, and an increased risk of skin cancer. UV radiation damages DNA and other cellular structures, causing mutations that can lead to cancer development. In addition to these short-term health effects, UV radiation has also been linked to long-term health risks, such as an increased risk of developing other types of cancer, such as breast, bladder, and colon cancer.

Therefore, military organisations must promote proper hydration to prevent heat-related illnesses and maintain general health during UVR exposure to mitigate the acute and severe health impacts of UVR exposure. Regularly applying broad-spectrum sunscreen with a high sun protection factor (SPF) and the reapplication of sunscreen after swimming or sweating should also be promoted for military outdoor workers. During intense UVR exposure, particularly during peak sunshine hours, military outdoor workers should regularly be reminded to take rest breaks in shaded areas. To protect their eyes from UVR exposure, military outdoor workers should also wear appropriate eyewear with UV protection.

An extensive literature review was conducted in Chapter 2 to demonstrate the knowledge and understanding of the effects of UV radiation on military outdoor workers.

Chapter 3 will then discuss the methodology used to measure the exposure of military outdoor workers to environmental and personal UV radiation.

CHAPTER 3: METHODOLOGY

3.1 Introduction

This chapter details the materials and methods employed to achieve the study objectives and, consequently, the aim of this study. It lays out the study design, study setting, population, sampling method and size, and the measurement tools used to collect data. This study used the following research tools to achieve the stated objectives: a self-administered questionnaire, an electronic ultraviolet dosimeter, and a WBGT meter. **Figure 3.1** below illustrates the steps for the methodology process of the research paper.

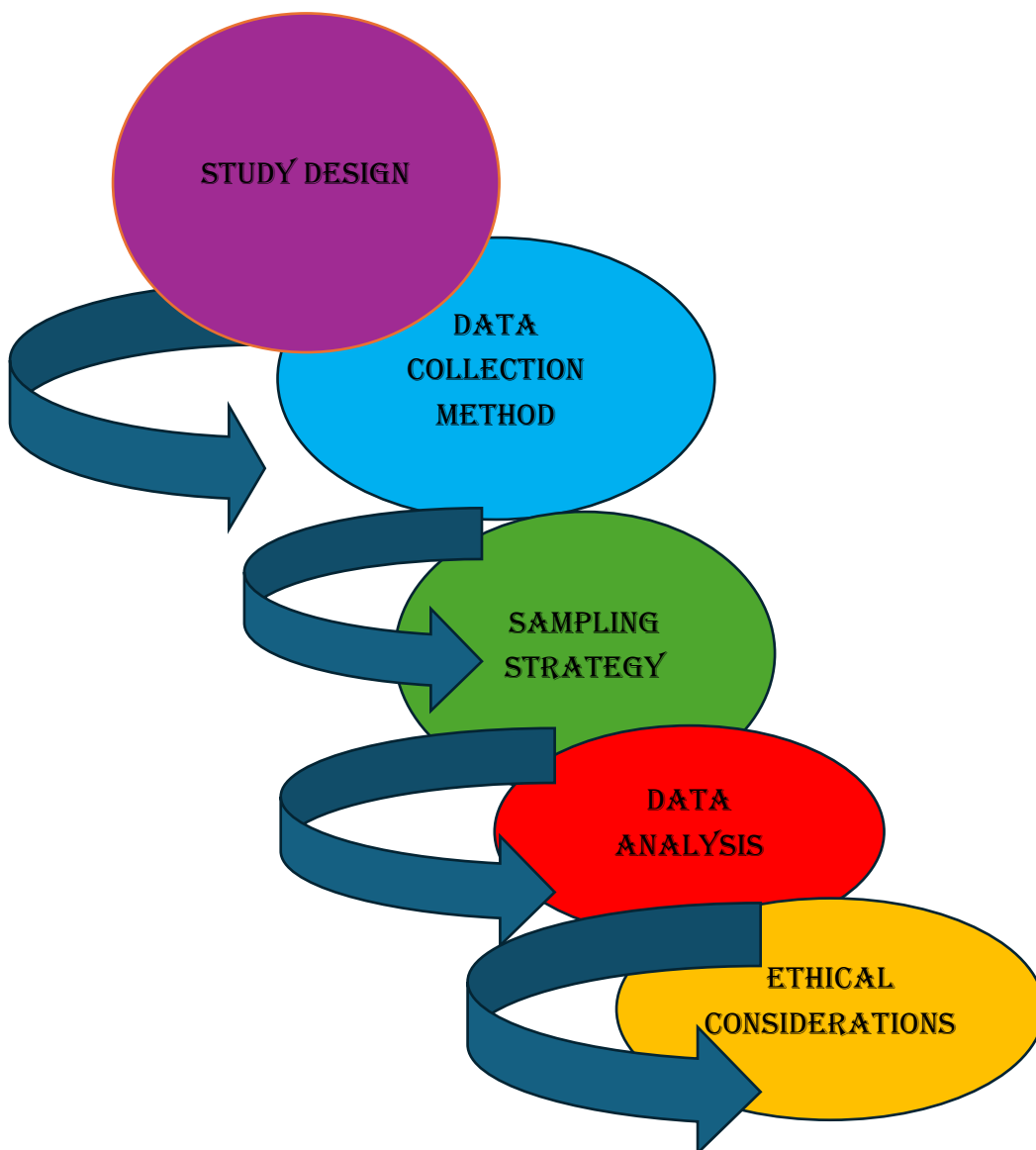


Figure 3.1: A visual representation of the methodology

3.2 Materials and methods

3.2.1 Study design

The assessment of ultraviolet radiation (UVR) exposure among military outdoor workers in Lohatla, Northern Cape, employed a cross-sectional study. A sample of military personnel engaged in outdoor activities at the Lohatla military base was recruited through stratified random sampling to ensure a representative cohort across various ranks and job roles. Quantitative data were collected using electronic UV dosimeters, which measured ambient UVR exposure over a specified period. Additionally, participants completed a self-administered questionnaire that gathered demographic information, job roles, awareness of UVR risks, and protection practices. The study was conducted over three months to account for seasonal variability in UVR levels. Statistical analyses included descriptive statistics to summarise demographics and UVR exposure levels, as well as inferential statistics to explore correlations between UVR exposure and health-related outcomes. Ethical approval was obtained from the relevant military and health authorities, and informed consent was obtained from all participants before data collection. This assessment aimed to provide valuable insights into UVR exposure levels among military outdoor workers and inform future sun safety interventions within the military.

3.2.2 Study setting

The study was conducted at Lohatla Military Base in Kathu, situated in South Africa's Northern Cape Province, characterised by a semi-arid climate featuring scorching summers and mild winters. Winter temperatures can drop to around 0 °C at night, while summer averages often exceed 35 °C. The region experiences minimal rainfall, averaging between 300 and 500 mm per year, predominantly during the summer months, resulting in prolonged sunshine that increases UV radiation exposure risk for outdoor workers. Additionally, strong winds, particularly in spring, can lead to dust storms, further intensifying UV exposure by dispersing dust particles and causing skin irritation and other health issues. These environmental conditions highlight the critical need for protective measures against UV radiation among military personnel engaged in outdoor activities, as illustrated in **Figure 3.2**: Lohatla Military Base and **Figure 3.3**: Study area map.

This remote location offers numerous advantages for military training and operations. The wide-open spaces and diverse terrain surrounding the base provide optimal conditions for executing large-scale military exercises, including live-fire drills, armoured vehicle manoeuvres, and air support operations. Lohatla is situated in the northern part of the Kalahari Desert, characterised by nearly year-round sunshine. The town of Kathu, located at a latitude of 27 °S and an altitude of 1,238 meters, benefits from relatively clear skies throughout most of the year. Consequently, this area experiences elevated levels of solar ultraviolet radiation (UVR), which increases the risk of severe exposure for individuals who spend prolonged periods outdoors, such as outdoor workers. This study involved military personnel from the South African National Defence Force (SANDF) stationed at the South African Army Combat Training Centre in Lohatla, Northern Cape.



Figure 3.2: Lohatla Military Base (defenceWeb, 2024).

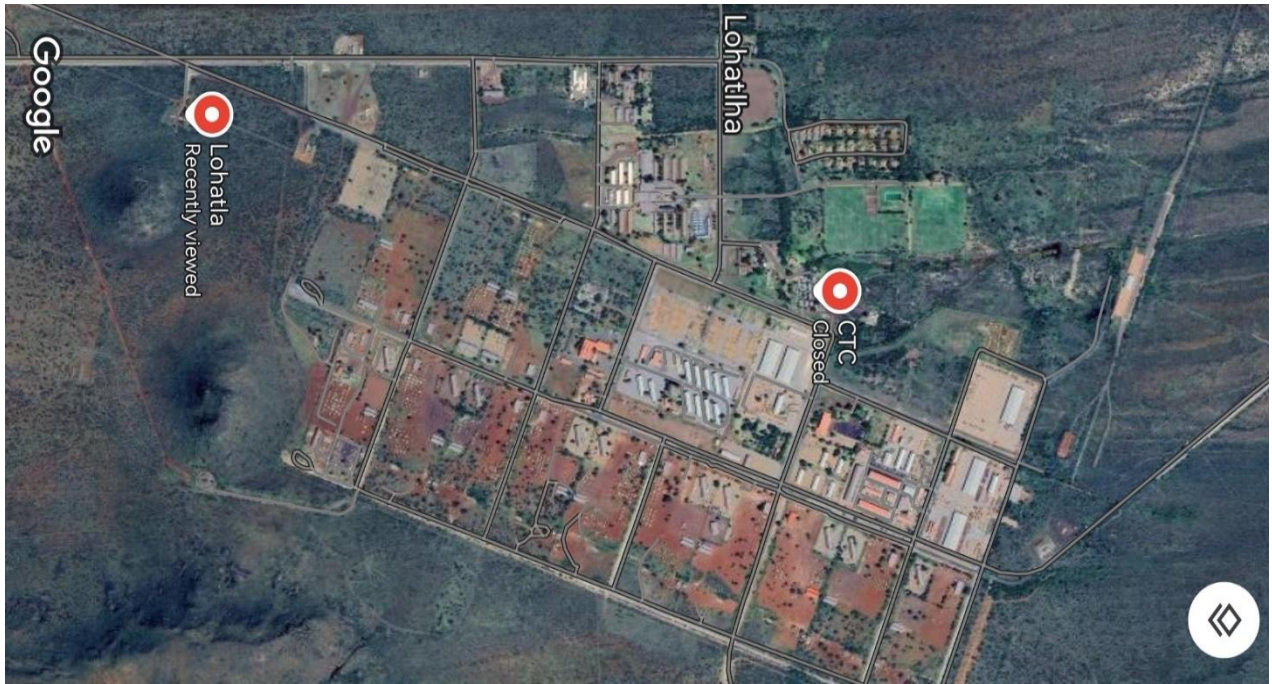


Figure 3.3 Study area map (defenceWeb, 2024).

3.2.3 Study population

The researcher sought permission from the SANDF (Annexure A), the employer of the military outdoor workers under investigation. The study targeted military outdoor workers in Lohatla, Northern Cape, South Africa. The research participants included male and female troops aged 18 to 60, representing the predominant age group of active military personnel. Participants had varying service durations; some were recently deployed, and others were stationed at Lohatla for extended periods. This variability was crucial in assessing the impact of different exposure durations on UVR levels and related health effects. The study population were South African military personnel, aligning with national demographics. Participants came from diverse socioeconomic backgrounds, some from rural areas and others from urban environments, which may have influenced their awareness of sun protection measures and previous UVR exposure. Alvi (2016) defines the study population as all members who met the specific criteria established for the research investigation. The sample size was calculated using the Centres for Disease Control and Prevention (CDC) version 7.2.2.6 for cross-sectional studies. The assumed frequency of military outdoor workers was 50% to determine the sample size. With a margin of error of 5%, the minimum required sample size was 200, adjusted for various covariates at a 95% confidence level. Figure 3.4 illustrates the sample size estimation using EPINFO 7.2.

Population survey or descriptive study
For simple random sampling, leave design effect and clusters equal to 1.

Population size:

Expected frequency: %

Acceptable Margin of Error: %

Design effect:

Clusters:

Confidence Level	Cluster Size	Total Sample
80%	118	118
90%	164	164
95%	200	200
97%	222	222
99%	257	257
99.9%	302	302
99.99%	328	328

Figure 3.4: Sample size estimation using EP INFO 7.2

3.2.4 Sampling

Participants in the study were chosen from the 2023 Lohatla training intake. This method of selecting participants from a subset of the broader military personnel population enabled targeted research that remained pertinent to the study area. The researcher collected data from a homogeneous group with similar training backgrounds and experiences by focusing on the 2023 training intake. Every employee in each section had the same chance of being selected.

3.2.5 Sampling method and size

Using a stratified random sampling method, the researchers organised 419 military personnel engaged in outdoor activities into ten strata, each containing 40 individuals. This structure facilitated targeted selection based on specific attributes, such as years of service in the South African National Defence Force (SANDF), categorised as follows: ≤ 2 years, > 2 but ≤ 5 years, > 5 but ≤ 10 years, and > 10 years. Volunteers who consented to participate were selected by choosing every second individual from each experience category. A sample size of 200 was determined to ensure sufficient statistical power to identify differences in UV exposure and compliance with protective measures across the strata, as shown in **Figure 3.4**. In the end, 161 participants provided informed consent, resulting in a consent rate of approximately 81%, which is considered acceptable for the research study. The sampling framework was further refined by calculating the number of employees to be sampled from each operational section within the military base. **Table 3.1** summarises this allocation, detailing the sections, their total number of employees, and the corresponding sample sizes based on 38% of the total workforce. The sections included Instructors, New Appointed/MSDS personnel, Students on Course, those Doing Retraining, Preparing for Deployment, Access Control/Guard staff, and other categories.

Table 3.1: Calculation of the number of employees to be sampled from each section

Section	No of employees	40% of the total employees sampled	No of employees
Instructor	40	$38/100 \times 40 = 15.2$	15
New Appointed/MSDS	95	$38/100 \times 95 = 36.1$	36
Student on course	60	$38/100 \times 60 = 22.8$	23
Doing retraining	65	$38/100 \times 65 = 24.7$	25
Preparing for deployment	90	$38/100 \times 90 = 34.2$	34
Access control/ Guard	78	$38/100 \times 78 = 29.7$	30
Other	96	$38/100 \times 98 = 36.5$	37
Total	419	100%	200

3.3 Inclusion criteria

The criteria for Inclusion were the following: 1) Being an adult (18 years of age or older). 2) Working for the SANDF. 3) Working in outdoor environments where UVR is present. The study also encompasses individuals with and without preexisting medical conditions to evaluate the effects of UVR exposure on various health profiles. In addition, participants undergoing chronic medical treatments are assessed to determine potential interactions between the treatments and exposure to ultraviolet radiation (UVR).

3.4 Exclusion criteria

Criteria for exclusion included the following: 1) Having a family history of cataracts, skin cancer, or skin cancer. 2) History of outdoor work before SANDF employment to reduce confounding variables associated with previous outdoor work experiences by ensuring that participants' UVR exposure is primarily attributed to their current occupation. The study examines the effects of UVR exposure on SANDF employees' health while accounting for variables that could distort the results by putting these inclusion and exclusion criteria into practice.

3.5 Participants' recruitment

The training officer assisted in finding volunteers interested in participating in the study during the recruitment phase. A presentation about the study was given to volunteers in a military conference hall. An informed consent form and a study participant pamphlet were provided to those willing to participate in the research. Both written materials and verbal invitations were presented in English, as it was the SANDF's official language of instruction. Participants were given a self-administered questionnaire to answer. When selecting participants, every effort was made to ensure that the process was fair and that each candidate had an equal chance of being chosen based on the established criteria.

3.6 Data collection tools

3.6.1 Questionnaire

The researcher meticulously crafted the questionnaire, prioritising clarity and comprehensiveness. Before it was implemented, a pilot study was conducted to verify the accuracy and effectiveness of the content. The questionnaire was tested on a small group to identify any potential issues and enhance the questions based on feedback from the participants. To supplement data collected using the electronic UV dosimeter, structured questionnaires were self-administered to gather detailed information on participants' outdoor activities, protective measures, and any reported skin conditions or symptoms of UV exposure. The self-administered questionnaire consisted of 22 closed-ended questions and was divided into three sections: demographic questions, work, and health-related information. Demographic questions collected basic details such as age, gender, ethnicity, and level of education. The work-related questions gathered data about job titles, time spent outdoors, use of sunscreen, protective gear, and awareness of UV radiation risks. The last section, health-related questions, focused on participants' symptoms of UV-related health risks such as excessive tearing, lazy eye, dry eye, blurred vision, soft bumps, brown spots, wrinkles, sunburn, sunspots, and dry skin. All participants who provided informed consent were required to complete these self-administered questionnaires, ensuring that the study captured UVR exposure data from the electronic UV dosimeters and self-reported symptoms for a more comprehensive analysis. The questionnaire was administered from December 2023 to February 2024. This extended timeframe allowed for thorough data collection, ensuring a diverse range of responses was gathered to enhance the study's findings. The questionnaire design was based on previous well-established research, ensuring its accuracy and relevance (Seité et al. 2017; Janjani et al. 2019).

3.6.2 Electronic UV dosimeter and WBGT meter

Electronic UV dosimeters were employed in the study to assess military personnel's exposure to ultraviolet radiation (UVR) accurately. These advanced instruments are explicitly designed to measure erythemal UVR, which ranges from 280 nm to 400 nm (Wright et al., 2007; Hammond et al., 2009; Nkogatse et al., 2019). The electronic UV dosimeter offers several vital features that enhance its utility in field conditions. One of the most significant advantages is their data download capability, allowing researchers to transfer collected data for analysis quickly. Additionally, these electronic UV dosimeters are equipped with onboard data logging, enabling continuous monitoring of UVR exposure throughout the day without constant supervision (Wright et al., 2007; Hammond et al., 2009; Nkogatse et al., 2019). Using these sophisticated electronic UV dosimeters, the study comprehensively assessed UVR exposure levels among military personnel, contributing valuable data to inform protective measures and health guidelines. Additionally, the Wet Bulb Globe Temperature (WBGT) index was employed to monitor heat stress conditions during training exercises, providing essential insights into how temperature and humidity could influence the effects of UV exposure.

3.7 Measurement methods

The researcher meticulously gathered data by evaluating ultraviolet (UV) radiation exposure alongside self-reported symptoms among military personnel engaged in outdoor work. To quantify environmental ambient UVR exposure during various outdoor activities, electronic UV dosimeters were utilised. These devices provided precise measurements of UV radiation levels, thereby offering a reliable assessment of the participants' exposure in real-time conditions. In collaboration with these measurements, a structured, self-administered questionnaire was distributed to the participants. This questionnaire was designed to capture a wide range of information, including demographic details such as age, gender, and rank, as well as work-related factors, including hours spent outdoors, types of tasks performed, and protective measures taken against UV exposure. Furthermore, the questionnaire included specific sections dedicated to health effects, prompting participants to report any symptoms they experienced, such as skin burns, eye discomfort, or other UV-related health issues. By employing this dual approach—measuring ambient UV exposure and collecting subjective health reports—the study aimed to create a comprehensive understanding of the relationship between UV radiation exposure and health outcomes in military outdoor workers.

3.7.1 Surveys and questionnaires

Structured surveys and questionnaires were administered to gather information on the participants' outdoor activities, protective measures (e.g. sunscreen, clothing), and any reported skin conditions or symptoms of UV exposure. All consented participants were asked to complete questionnaires to provide additional context and personal data relevant to the study.

3.7.2 Ambient UVR and Heat stress exposure measurement

Throughout the study, the measurement of daily ambient (environmental) ultraviolet radiation (UVR) was key to determining the maximum UVR exposure on each study day. The electronic UV dosimetry technology employed in this research offers distinct advantages over satellite data, as it provides a more accurate reflection of local environmental conditions by accounting for factors such as cloud cover, aerosols, and regional variations (Kimlin et al., 2019). To ensure precise ambient UVR measurement, an electronic UV dosimeter was strategically positioned in a flat, unobstructed area at each study site, guaranteeing full exposure to sunlight throughout the day. Monitors were installed and replaced daily after sunset, allowing for the collection of ambient UVR data starting at sunrise the following day. This particular approach ensured that the dosimeters recorded the entire spectrum of UVR exposure throughout daylight hours. Ambient UVR levels were measured twice at each location over five consecutive working days, specifically on the first and last days of each data collection period. Data collection occurred from December 2023 to February 2024, with all measurements systematically documented using a designated data collection sheet (refer to Annexure C).

Heat stress exposure was assessed via measurements of the Wet Bulb Globe Temperature (WBGT; QuesTemp 34, QUEST Technologies, Oconomowoc, WI, USA), which has an accuracy level of ± 0.5 °C between 0 °C and 120 °C of dry bulb temperature and $\pm 5\%$ relative humidity (RH) between 20% and 95% RH. The WBGT combines the effects of four main thermal components affecting heat stress: air temperature, humidity, air velocity, and radiation, as measured by the dry bulb, wet bulb, and globe temperatures. Globally, the WBGT index is the most widely used heat index in heat stress assessments and is employed by many international organisations to define heat exposure thresholds or limits for workers (Venugopal et al., 2015).

Ambient WBGT measurements were recorded during regular working hours, specifically between 10:00 and 16:00. Before taking ambient WBGT measurements, the QuesTemp device was calibrated at the start and end of each measurement day to ensure accuracy. The

QuesTemp was positioned at a height of 1.1 m above the ground, utilising a tripod mount to prevent any obstruction from objects that might block radiant heat. The researcher allowed the equipment to stabilise for approximately 15 minutes before taking measurements at each location. The number of places where WBGT measurements were taken varied depending on the work intensities of the workers and the potential heat exposure zones within each workstation (Kimlin et al., 2019). **Figure 3.5** illustrates a similar instrument setup used for ambient WBGT measurements, emphasising the standardisation of measurement techniques in such occupational settings (Carter et al., 2020).

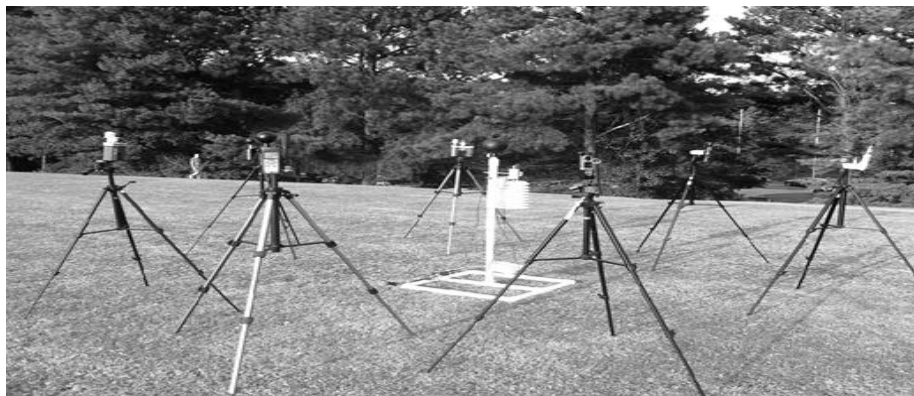


Figure 3.5: A similar instrument was prepared for ambient WBGT measurements (Carter et al., 2020)

This study measured ambient UV exposure to military soldiers working outdoors using a comparable EUV dosimeter. However, to prevent any disruptions during the UV measurements of environmental ultraviolet radiation in various working areas, an electronic UV dosimeter was set up flat on the ground without any obstructions, and the workers did not wear it on the upper left arm. Furthermore, the ultraviolet (UV) data-gathering method did not include employee photos due to the sensitivity, privacy and secrecy of information within the South African National Defence Force (SANDF). This action was performed under stringent privacy regulations and ethical concerns to protect employees and delicate operational situations. See the attached Appendix B letter for details. **Figures 3.6 and 3.7** illustrate similar instrumentation and protocols employed in occupational UV exposure monitoring. **Figure 3.6** shows a construction worker wearing the GENESIS-UV dosimeter on the upper left arm, demonstrating the conventional personal dosimetry method (Modenese et al., 2020). **Figure 3.7** shows the GENESIS-UV system components, including (a) the electronic UV dosimeter X-2012-10 with its technical specifications, and (b) the dosimeter connected to a tablet PC for data management, highlighting the state-of-the-art technology utilised for long-term UV exposure monitoring (Modenese et al., 2020). The present study adopted a similar instrument and followed comparable measurement protocols, but adapted the dosimeter placement method due to operational and ethical considerations.



Figure 3.6: A construction worker wearing the GENESIS-UV dosimeter on the upper left arm (Modenese et al., 2020)

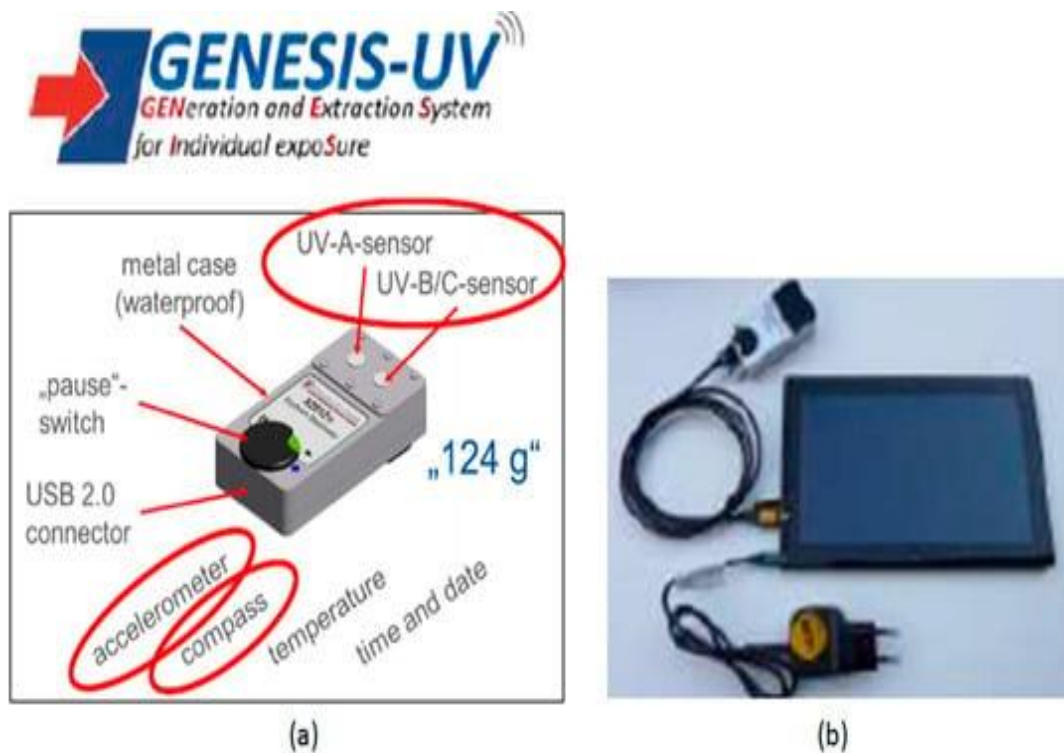


Figure 3.7: The GENESIS-UV system for long-term occupational UV exposure monitoring: (a) the electronic UV dosimeter X-2012-10 and its characteristics; (b) the dosimeter connector to a tablet PC (Modenese et al., 2020)

3.8 Validity and reliability of measurement instruments

This study ensured content validity by deriving questionnaire items from validated and widely used instruments. Additionally, further content validation was achieved by conducting a pilot study before the main study, which allowed for refinement and confirmation of the questionnaire's relevance and comprehensiveness (Polit & Beck, 2017).

The WBGT meter was calibrated before the commencement of the study, ensuring that the measurements obtained were accurate and reliable. On the other hand, reliability is defined as the measurement tool's consistency. The reliability measures were ensured through the recent calibration of the electronic UV dosimeters and the WBGT meter. Furthermore, the pilot study provided an opportunity to evaluate the reliability of the questionnaire by examining the consistency of participants' interpretations of the questionnaire items. This dual approach to assessing reliability through calibration and pilot testing ensures that the instruments used in this study yield consistent and dependable results.

3.9 Pilot study

The pilot study was conducted with 20 South African National Defence Force (SANDF) members at Lohatla to assess the reliability and validity of the measurement instruments utilised in the main study. To prevent any bias in the results, participants in the pilot study were excluded from the subsequent research. Before data collection, the electronic UV dosimeter and the Wet Bulb Globe Temperature (WBGT) meter underwent thorough calibration to ensure accurate readings. Additionally, pre-measurements were conducted to verify the instruments' functionality, thereby enhancing the integrity of the data collected during the main study. This meticulous approach stresses the commitment to obtaining reliable and valid measurements of ultraviolet radiation exposure among military outdoor workers.

3.10 Data analysis

Several statistical methods were used to interpret the data correctly and efficiently during the statistical data analysis. The Statistical Package for the Social Sciences (SPSS), frequently used for statistical analysis in social science research, was used to conduct the study (IBM

Corp., 2019). Specifically, this was utilised by IBM SPSS Statistics for Windows, version 26.0 (Armonk, NY: IBM Corp).

Descriptive and Inferential statistics were employed to summarise and describe the sociodemographic information of the study participants and the UV measurements obtained through specific measurement tools. Key variables included age, sex, duration of employment, and the amount of UV radiation measured. For numerical variables, relevant measures of central tendency (i.e. mean) and dispersion (i.e. standard deviation) were calculated, with the normality of the variables assessed using the Shapiro-Wilk test.

Inferential statistics were applied to analyse the data as follows:

- Multiple linear regression analysis, independent samples t-tests, chi-square tests, and ANOVA were employed to evaluate the effect of sun protection practices on health outcomes.
- A one-way ANOVA was used to examine the variation in average temperatures over five days, with the alternative hypothesis (H1) indicating at least one difference from the null hypothesis (H0). A t-test was used for comparisons.
- Multiple regression analysis, the chi-square test, the ANOVA, and the Pearson correlation coefficient were among the statistical tests used to assess the relationship between demographic traits and the health effects of UV exposure.

3.11 Ethical statement

The researcher obtained ethical approval from the relevant ethics committees such as the 1 Military Hospital Research Ethics Committee (1MHREC number: 1MH/302/6/02.10.2023) and the Faculty of Health Sciences Research Ethics Committee at the University of Free State (UFS HSREC number: UFS-HSD2023/1227/2811), before conducting a study involving human participants. The study was voluntary, with no personal identifying information recorded. Participants could withdraw consent before submitting questionnaires, but withdrawal after submission was not feasible due to anonymity. Confidentiality was ensured by the Bill of Rights Chapter 2:16 Right to Freedom of Expression (Constitution of the Republic of South Africa, 1996) and the Protection of Personal Information Act (South African Government, "Protection of Personal Information Act). Informed consent was obtained, and responses were coded to eliminate personal identifying elements. Participants completed the questionnaires in a private setting.

3.12 Data management

Upon signing informed consent to participate in the study, participants were assigned a unique identification number. The unique study identification numbers were associated with participants' data during collection, capturing and analysis. Information linking the participants' names, study identification number, and other electronic information was kept in an electronic file on the researcher's password-protected computer. All completed questionnaires and paper data were stored in locked file cabinets in a locked office accessible only by the researcher and study supervisor. The researcher was responsible for managing the data throughout the research project. However, the study supervisor will destroy the data three years after the completion of the study.

3.13 Summary and transition

In summary, Chapter 3 of this study is an overview of the methods followed to meet its objectives. This chapter discussed the validity and reliability of study measurement tools and the ethical considerations related to the research.

CHAPTER 4: RESULTS

4.1 Introduction

This chapter thoroughly examines the connections between research participants' sociodemographic traits, occupational factors, reported exposure symptoms, and UVR protection practices. It will investigate how these factors affect UVR exposure, health consequences, and how well sun protection techniques work. The results are intended to provide a thorough framework for comprehending the various aspects having an impact on UVR exposure and protection and to guide focused strategies for reducing UVR-related health risks in outdoor occupational contexts.

4.2 Sociodemographic, occupational factors, exposure symptoms and UV protection measures

4.2.1 Descriptive results

This chapter presents the questionnaire survey results and environmental measurements detailed in Chapter 3. Initially, 200 participants were invited to participate in the study and, upon providing consent and completing a questionnaire, 161 questionnaires out of 200 were completed, providing a completion rate of 81%. The questionnaire survey was completed by 161 military outdoor workers, comprising males (n=94, 58.39%) and females (n=67, 41.62). The age category with the highest study population was 19 to 25 (n=51, 31.68%). Most study participants had a matric (n=115, 71.43%) as the highest qualification, with the least being a postgraduate (n=2, 1.24%). Table 4.1 outlines the sociodemographic characteristics of study participants.

Table 4.1: Participants' sociodemographics and occupation data

Sociodemographic		Frequency (n)	Percentage (%)
Age	19 to 25 years old	51	31.68%
	26 to 30 years old	34	21.12%
	31 to 40 years old	46	28.57%
	41 years or older	30	18.63%
Gender	Female	67	41.62%
	Male	94	58.39%
Education level	Matric	115	71.43%
	Diploma	34	21.12%

	Degree	10	6.21%
	Postgraduate degree	2	1.24%
Ethnicity	Black	137	85.09%
	White	10	6.21%
	Indian	10	6.21%
	Coloured	4	2.49%
	Other	0	0%
Occupation	Instructor	5	3.11%
	New appointed/MSDS	43	26.70%
	Student on course	0	0%
	Doing re-training	1	0.62%
	Preparing for deployment	41	25.47%
	Access control/Guard	32	19.88%
	Other	39	24.22%
Duration of Employment	1 month to 2 years	102	63.35%
	> 2 years to ≤ 4 years	20	12.42%
	> 4 years to ≤ 6 years	17	10.56%
	> 6 years	22	13.67%

Most participants had employment durations of 1 month to 2 years, with the fewest being employed for more than 4 to 6 years. **Figure 4.1** below shows the age distribution of participants.

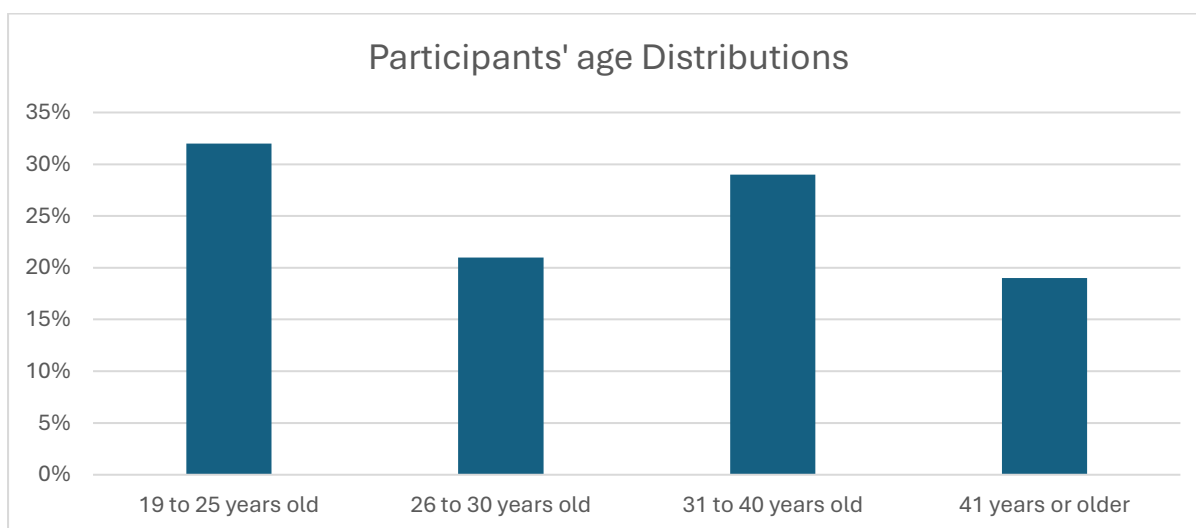


Figure 4.1: Participants' age distribution

The highest age category had the smallest number of participants (41 years or older), with the highest number of participants in the 19 to 25-year-old age category. In addition, males comprised up the highest proportion of the study participants. **Figure 4.2** below shows the gender distribution of the participants.

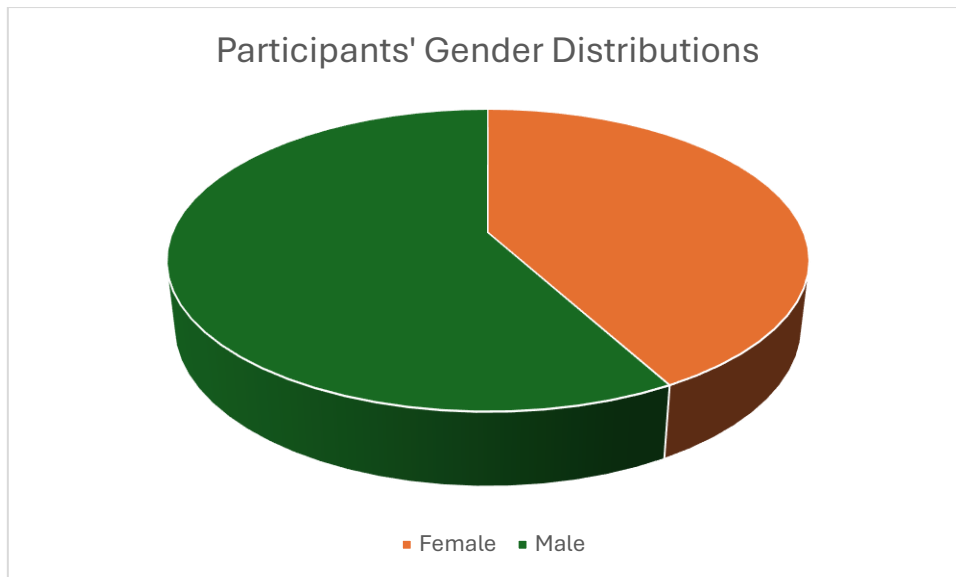


Figure 4.2: Participants' gender distributions

4.2.2 Correlations between sun protection behaviours and health outcomes

The analysis revealed several significant relationships between sun protection behaviours and health outcomes. Table 4.2 summarises these correlations, which provide insights into the protective behaviours of military outdoor workers and the associated health outcomes.

Table 4.2: Correlations between self-related symptoms and UV protective behaviours

Summary of key correlations					
Categories	Variable 1	Variable 2	Correlation Coefficient	p-value	Interpretation
UV Exposure and Protective Measures	Wearing Clothes that cover Arms & Legs	Avoiding Sun (12:00-15:00)	0.530	$P < 0.001$	Strongly positive correlation: Those who cover up avoid exposure to peak sun hours.
		Sunscreen Use	0.475	$P < 0.001$	Strongly positive correlation: Those who wear protective clothing are also likely to use sunscreen.
	Working Around Reflective Surfaces	Sunscreen Use	0.213	$P = 0.007$	Moderately positive correlation: Reflective surfaces prompt more frequent sunscreen use.
UV Exposure and Eye Health Symptoms	Working Around Reflective Surfaces	Blurred Vision	0.217	$P = 0.006$	Moderately positive correlation: Working around reflective surfaces is linked to blurred vision.
Protective Behaviours	Using a hat	Wearing Clothes that Cover Arms/Legs	0.701	$P < 0.001$	Strongly positive correlation: Those who wear hats are more likely to cover their arms and legs.
		Avoiding Sun Between 12:00 and 15:00.	0.637	$P < 0.001$	Strongly positive correlation: hat users will also likely avoid peak sun hours.
	Sunscreen use	Avoiding Sun Between 12:00 and 15:00.	0.587	$P < 0.001$	Strongly positive correlation: Sunscreen users are likelier to avoid peak sun exposure.
Health Outcomes and Protective Measures	Brown spots	Sunscreen Use	0.426	$P < 0.001$	Significantly positive correlation: sunscreen use is associated with fewer brown spots.
		Avoiding Sun Between 12:00 and 15:00.	0.256	$P = 0.001$	Significantly positive correlation: avoiding peak sun exposure helps prevent brown spots.
	Sunburn	Sunscreen Use	0.319	$p < 0.001$	Strongly positive correlation: sunscreen use is associated with a lower incidence of sunburn.
		Covering Arms and Legs	0.256	$p = 0.001$	Significantly positive correlation; covering up helps reduce the likelihood of sunburn.
	Eye pain	Sunscreen Use	0.216	$P = 0.006$	Weakly positive correlation: Sunscreen use may slightly reduce eye pain.

Table 4.2 analyses key correlations between sun exposure, protective measures, and health outcomes, and reveals significant relationships. A strongly positive correlation exists between wearing clothes that cover the arms and legs and avoiding sun exposure between 12 and 3 PM ($r = 0.530$, $p < 0.001$) and sunscreen use ($r = 0.475$, $p < 0.001$), indicating that individuals who adopt protective clothing are also more likely to engage in additional sun protection behaviours. Similarly, working around reflective surfaces moderately correlates with sunscreen use ($r = 0.213$, $p = 0.007$), suggesting increased sunscreen application among those exposed to reflective environments.

Health outcomes further illustrate the impact of UV exposure. A moderately positive correlation was found between working around reflective surfaces and blurred vision ($r = 0.217$, $p = 0.006$), highlighting potential eye health risks. Additionally, sunscreen use showed a weak but significant correlation with reduced eye pain ($r = 0.216$, $p = 0.006$). Regarding protective behaviours, using a hat is strongly correlated with both wearing protective clothing ($r = 0.701$, $p < 0.001$) and avoiding peak sun hours ($r = 0.637$, $p < 0.001$), reflecting a comprehensive approach to sun protection. Sunscreen use is also strongly linked to avoiding sun exposure during peak hours ($r = 0.587$, $p < 0.001$). Finally, in terms of health outcomes, sunscreen use is significantly associated with fewer brown spots ($r = 0.426$, $p < 0.001$) and a lower incidence of sunburn ($r = 0.319$, $p < 0.001$). Avoiding peak sun exposure is also associated with reducing brown spots ($r = 0.256$, $p = 0.001$), and covering arms and legs helps to reduce the likelihood of sunburn ($r = 0.256$, $p = 0.001$). These findings emphasise sun protection strategies' interconnected nature and effectiveness in mitigating UV-related health risks. The visual presentation of the correlations is shown in **Figure 4.3**.

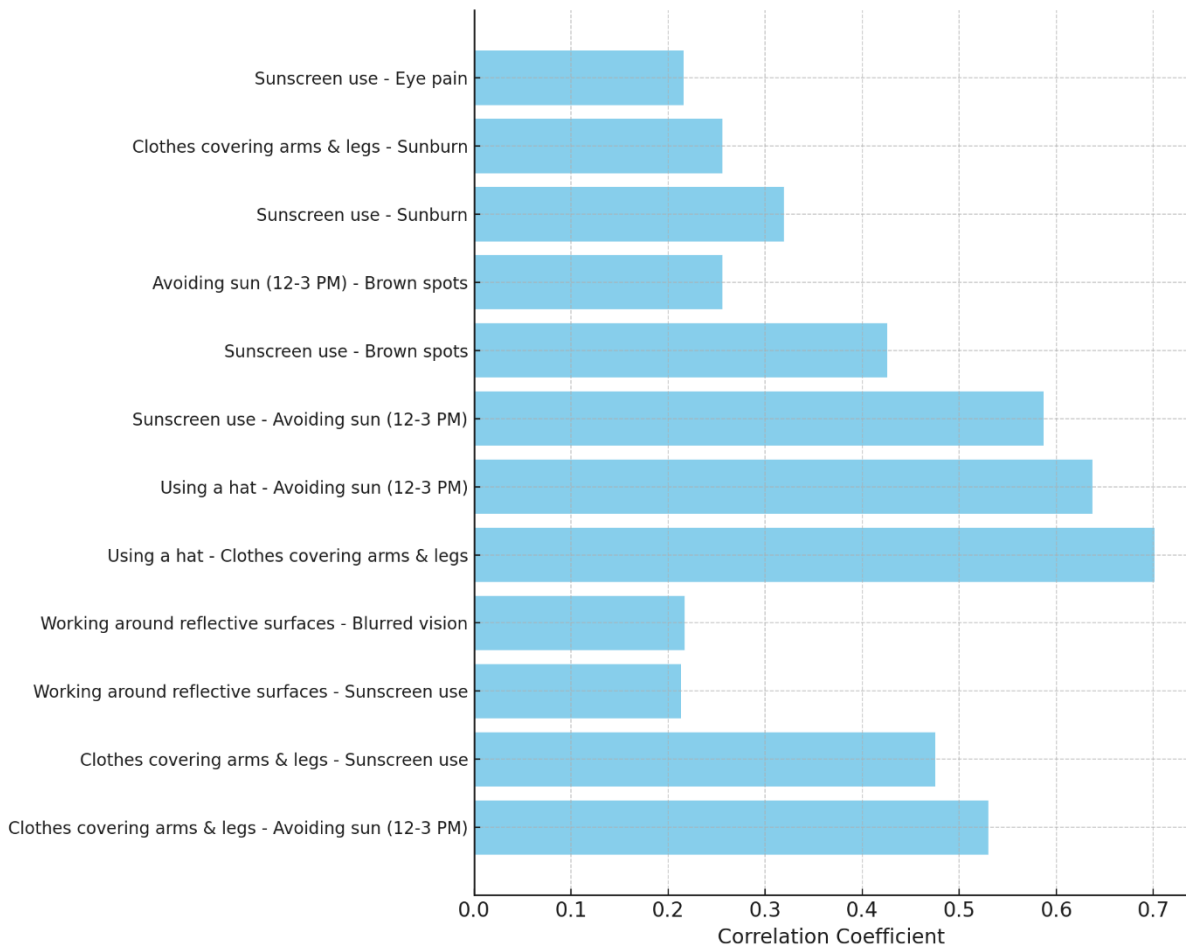


Figure 4.3: Summary of key correlations between sun exposure, protective measures, and health outcomes

In **Figure 4.3**, each bar indicates the strength of the relationship between protective measures (e.g. wearing clothes that cover the arms and legs, using sunscreen) and health-related variables (e.g. sunburn, blurred vision). Stronger correlations, such as the link between wearing protective clothing (clothes covering arms and legs) and avoiding peak sun exposure (between 12:00 and 15:00), suggest that individuals who adopt one protective behaviour are more likely to also engage in other protective behaviours, highlighting the interconnected nature of sun safety strategies. **Figure 4.4** demonstrates the UV protection strategies.

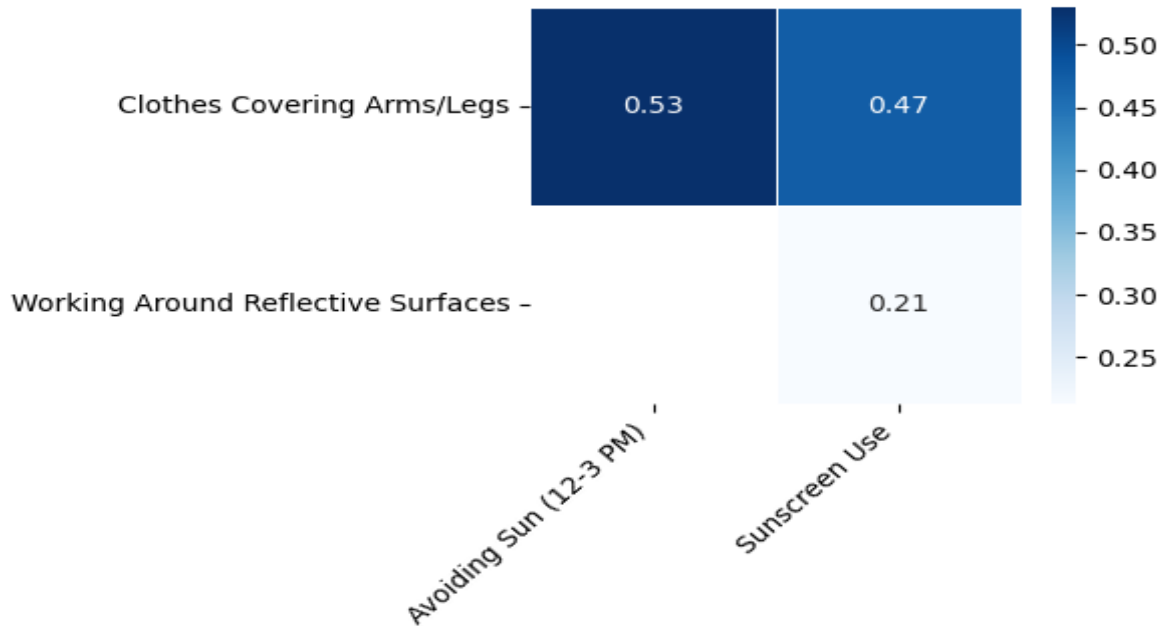


Figure 4.4: UV exposure and protective measures

Figure 4.4 illustrates the correlation between UV exposure prevention behaviours and environmental factors. The strongest correlation (0.53) is between covering arms and legs with clothing and avoiding sun exposure between 12:00 and 15:00, suggesting that these protective measures are often practised together. There is also a moderate correlation (0.47) between covering arms and legs and sunscreen use, indicating that individuals who cover their skin may also be more likely to use sunscreen. The correlation between working around reflective surfaces and sunscreen use is weaker (0.21), suggesting that those exposed to reflective surfaces may not consistently use sunscreen. Overall, the results indicate a strong relationship between using multiple sun protection strategies and highlighting gaps in sun protection behaviours for individuals exposed to reflective surfaces. **Figure 4.5** shows the correlation between blurred vision and UV exposure.

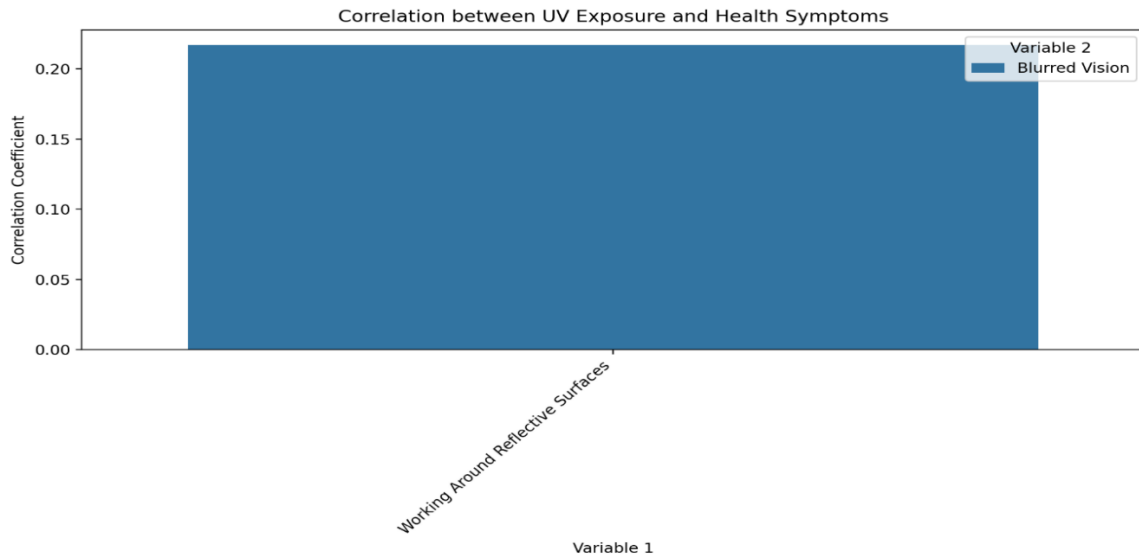


Figure 4.5: UV exposure and eye health symptoms

The bar chart displays the correlation between UV exposure, specifically working around reflective surfaces and blurred vision. The correlation coefficient is approximately 0.21, indicating a weak to moderately positive relationship. This suggests that individuals working around reflective surfaces may experience increased blurred vision, though the association is not particularly strong. The results imply that while exposure to UV via reflective surfaces may contribute to vision-related symptoms, it is not a primary factor, requiring further investigation into other potential causes or contributing factors. **Figure 4.6** shows sun protection behaviours.

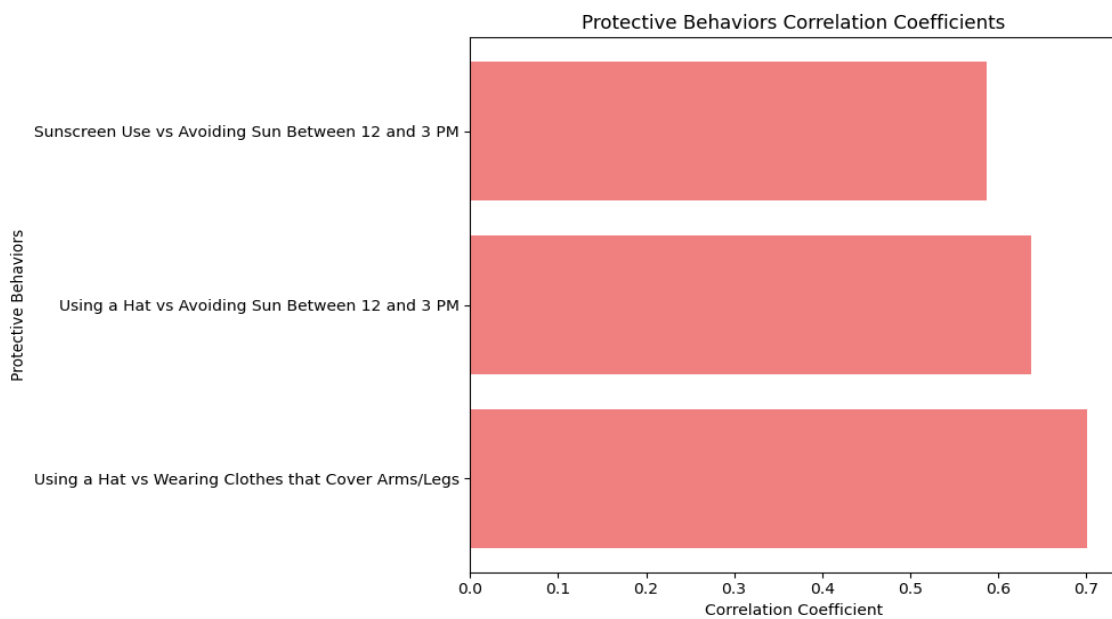


Figure 4.6: Correlations between various sun protection behaviours

Several strong correlations were identified among the participants in the analysis of sun protection behaviours. Firstly, a notably positive correlation was found between the use of hats and clothing covering the arms and legs ($r=0.701$, $p<0.001$). This suggests that individuals who use hats are also likely to adopt additional protective measures, such as covering more skin. Additionally, a strongly positive correlation was observed between hat usage and the avoidance of sun exposure during peak UV radiation hours (12-3 PM) ($r=0.637$, $p<0.001$). This indicates that those wearing hats are also inclined to avoid the sun during the most intense hours. Similarly, a robustly positive correlation exists between sunscreen use and avoiding sun exposure during peak hours ($r=0.587$, $p<0.001$). This implies that sunscreen users are also more likely to avoid high UV exposure times. These findings show a pattern where individuals committed to one form of sun protection, whether it be hats, sunscreen, or both, tend to employ a broader approach to minimising UV exposure – heat-map correlations between health outcomes and protective measures shown in **Figure 4.7**.

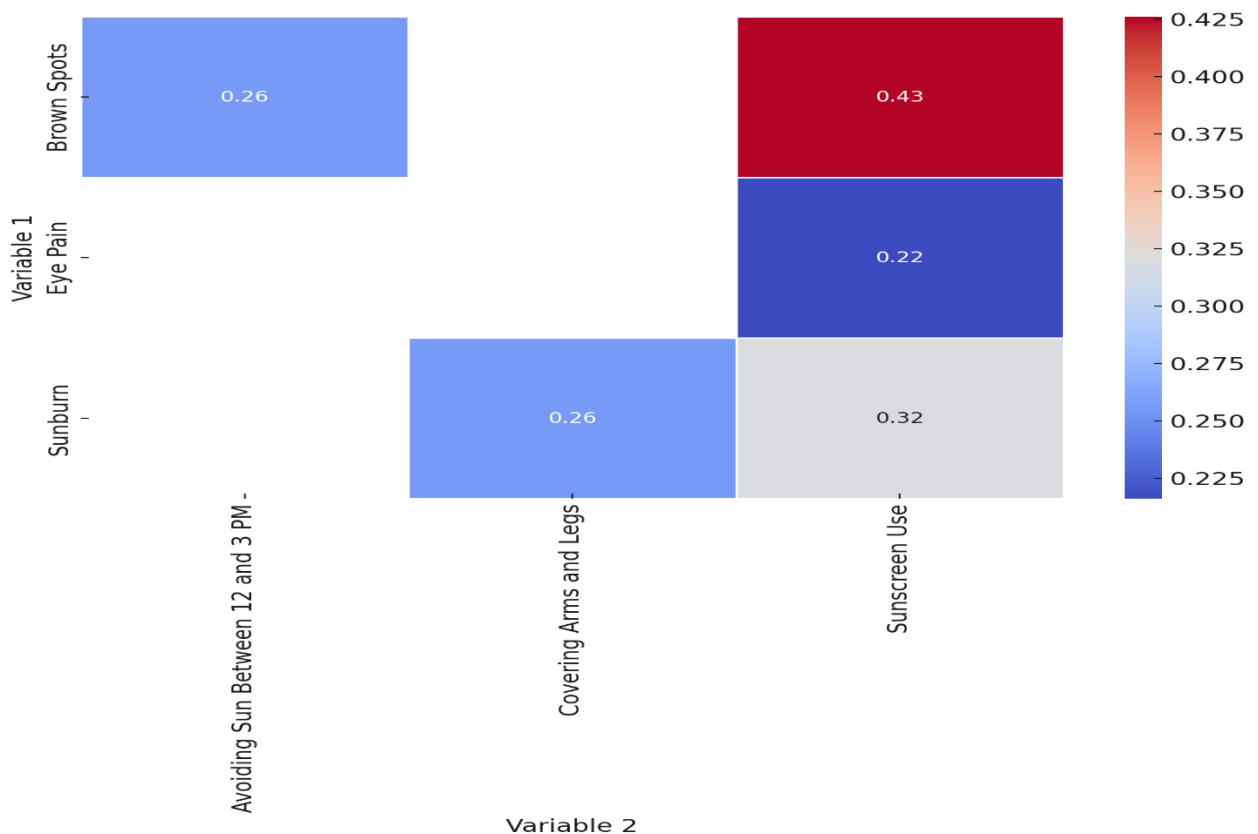


Figure 4.7: Heatmap of correlations between health outcomes and protective measures

The heatmap shows the relationships between sun protection behaviours and sun-related health effects. The strongest association (0.43) is between sunscreen use and eye pain, suggesting that increased sunscreen use may correlate with higher reports of eye discomfort. Sunscreen use also has a moderate correlation (0.32) with the development of brown spots, indicating that while protective, it may not entirely prevent skin issues. Sunburn is moderately

associated with avoiding the sun during peak hours (0.26) and covering arms and legs (0.26), though neither practice eliminates the risk. Overall, the results highlight varying degrees of protection provided by these behaviours. **Table 4.3** below shows the correlation between self-reported symptoms, education, occupational factors and protective behaviours.



Table 4.3: Correlation between education, occupational factors, symptoms and sun exposure protective behaviours

Category	Variable 1	Variable 2	(r)	p-value	Interpretation
Gender & Sun Protective Behaviours	Gender	Sunscreen Use	0.356	< 0.001	Significantly positive correlation
		Sunscreen Protection Level	0.425	< 0.001	Significantly negative correlation
		Hat Usage	0.195	0.013	Significantly positive correlation
		Wearing Protective Clothing	0.130	0.099	Non-significantly positive correlation
		Avoiding Sun Exposure Between 12:00 and 15:00	0.102	0.196	Non-significantly positive correlation
Gender & Health Effects		Sunburn	-0.183	0.020	Significantly negative correlation
		Eye Strain	-0.119	0.133	Non-significantly negative correlation
		Dry or Itchy skin	0.191	0.015	Significantly positive correlation
Education & Sun Protection Behaviours	Education	Sunscreen Use	0.419	< 0.001	Significantly positive correlation
		Timing of Sunscreen Application	-0.322	< 0.001	Significantly negative correlation
		UVA/UVB Protection Level of Sunscreen	-0.283	< 0.001	Significantly negative correlation
		Hat Usage	0.285	< 0.001	Significantly positive correlation
		Clothing Coverage (Arms and Legs)	0.328	< 0.001	Significantly positive correlation
		Avoiding the Sun between 12:00 and 15:00	0.178	0.024	Significantly positive correlation
		Sun Exposure During Work	-0.145	0.066	Non-significantly negative correlation
		Sunburn	0.299	< 0.001	Significantly positive correlation

Education & Health Effects		Dry or Itchy Skin	0.247	0.002	Significant lypositive correlation
		Eye Pain	0.085	0.069	No significantly positive correlation
		Wrinkles	0.124	0.118	Non-significantly positive correlation
Occupation & Sun Protection Behaviours	Occupation	Use of Sunglasses	0.293	< 0.001	Significantly positive correlation
		Wearing long Sleeves	0.102	0.198	Non-significantly positive correlation
		Sunscreen Use	0.031	0.699	Non-significantly positive correlation
Occupation & Health Effects		Dry Eyes	-0.216	0.006	Non-significantly negative correlation
		Blurred Vision	-0.150	0.058	Non-significantly negative correlation
		Eye Pain	0.085	0.283	Non-significant positive correlation
Duration of Employment & Sun Protective Behaviours	Duration of Employment	Use of sunglasses	-0.172	0.029	Significantly negative correlation
		Wearing a cap	-0.153	0.052	Negative correlation, approaching significance
		Wearing protective clothing	-0.109	0.169	Non-significantly negative correlation
		Wearing long sleeves	-0.008	0.922	Non-significantly negative correlation
		Sunscreen use	-0.031	0.694	Non-significantly correlation
Duration of Employment & Health Effects		Sunburn	-0.217	0.006	Non-significantly negative correlation
		Sunspots	-0.277	<0.001	Significantly negative correlation
		Skeletal/bony hands	-0.192	0.015	Significantly negative correlation

UV Exposure & Sun Protective Behaviours	Working Around Reflective Surfaces	Sunscreen Use	0.213	0.007	Non-significantly positive correlation
UV Exposure & Health Effects		Blurred Vision	0.217	0.006	Non-significantly positive correlation
Sun Protective Behaviours	Using a Hat	Wearing Clothes that Cover Arms/Legs	0.701	< 0.001	Significantly positive correlation
		Avoiding Sun Between 12:00 and 15:00	0.637	< 0.001	Significantly positive correlation
	Sunscreen Use	Avoiding Sun Between 12:00 and 15:00	0.587	< 0.001	Significantly positive correlation
Sun Protective Behaviours & Health Effects	Sunspots	Sunscreen Use	0.426	< 0.001	Significantly positive correlation
		Avoiding Sun Between 12:00 and 15:00	0.256	0.001	Significantly positive correlation
	Sunburn	Sunscreen Use	0.319	0.001	Significantly positive correlation
		Covering Arms and Legs	0.256	0.001	Significantly positive correlation
	Eye pain	Sunscreen Use	0.216	0.006	Non-significantly positive correlation

Higher education levels are generally associated with more proactive sun protection behaviours, such as sunscreen use ($r = 0.419$, $p < 0.001$), wearing hats ($r = 0.285$, $p < 0.001$), and wearing clothes that cover arms and legs ($r = 0.328$, $p < 0.001$). This proactive behaviour is also linked to a reduced incidence of sunburn ($r = 0.299$, $p < 0.001$). However, individuals with higher education levels may report more dry or itchy skin, potentially due to the more frequent use of sunscreens or protective products. No significant relationship exists between education levels and eye pain or wrinkles. These results suggest that higher education reduces the risk of sunburn, but it may also correlate with some skin conditions related to increased protective measures. A moderately positive correlation ($r = 0.293$, $p < 0.001$) was found between outdoor occupations and the use of sunglasses, suggesting that individuals in outdoor-related jobs are more likely to engage in this protective behaviour. However, other protective measures, such as wearing long sleeves ($r = 0.102$, $p = 0.198$) and applying sunscreen ($r = 0.031$, $p = 0.699$), show weak and non-significant correlations with occupation, indicating limited influence of occupational type on these sun protection behaviours. Regarding health effects, the correlation between occupation and sunburn is weak and non-significant ($r = -0.087$, $p = 0.274$), suggesting no meaningful association between job type and the incidence of sunburn. Conversely, a moderately negative correlation with dry eyes ($r = -0.216$, $p = 0.006$) implies that certain occupations might protect against this condition. The correlations for blurred vision ($r = -0.150$, $p = 0.058$) and eye pain ($r = 0.085$, $p = 0.283$) are weak and non-significant, indicating that occupation does not have a substantial impact these particular health effects.

In sun protective behaviours, there is a statistically and significantly negative correlation between the duration of employment and the importance of wearing sunglasses ($r = -0.172$, $p = 0.029$). This finding indicates that, as employment duration increases, employees are less likely to prioritise wearing sunglasses, possibly due to a reduced perception of risk or habituation to outdoor working conditions. A similar trend is observed for the importance of wearing a cap ($r = -0.153$, $p = 0.052$), where more extended employment is associated with a reduction in the perception of the importance of wearing a cap, approaching statistical significance. These results may suggest that as employees gain more experience, they become complacent about adhering to certain sun protection practices. On the other hand, non-significant correlations are found between employment duration and the importance of wearing protective clothing ($r = -0.109$, $p = 0.169$), long sleeves ($r = -0.008$, $p = 0.922$), or sunscreen use ($r = -0.031$, $p = 0.694$). These results suggest that certain protective behaviours remain consistent regardless of employment

duration, possibly because these behaviours are ingrained in work routines or mandated by workplace policies.

Regarding Health Effects, a significant negative correlation exists between employment duration and sunburn ($r = -0.217$, $p = 0.006$), suggesting that employees with more extended tenure experience fewer sunburn incidents. This could be attributed to improved adaptive behaviours over time, such as seeking shade, better planning to avoid peak sun exposure or a shift in job responsibilities that reduce direct sun exposure. A stronger negative correlation is observed between employment duration and sunspots ($r = -0.277$, $p < 0.001$). This indicates that employees with more extended employment are significantly less likely to report sunspots, a standard marker of chronic sun damage. These findings imply that employees with more experience might develop strategies to mitigate the cumulative effects of sun exposure. Interestingly, a significantly negative correlation is found between employment duration and skeletal/bony hands ($r = -0.192$, $p = 0.015$). This association suggests that more extended employment might be linked to physical strain or wear-and-tear injuries, possibly due to repetitive manual tasks over extended periods rather than sun exposure.

4.3 Environmental UV measurements and UV index

Measurements were taken to assess and compare the outdoor temperature over the five days. The readings were taken at seven intervals per day to account for the changing incident angle of the sun between 09:00 and 15:00, as shown in **Table 4.4**.

Table 4.4: Outdoor temperature during the measurement period

Days	Time of the day	Outdoor temperature (°C)	Min.	Max.	Range	Mean SD ±	p-value
1	09:00	26	26	36	10	31.86 ± 3.761	
1	10:00	28					
1	11:00	32					
1	12:00	32					
1	13:00	33					
1	14:00	36					
1	15:00	36					

2	09:00	28	28	37	9	33.57	0.185
2	10:00	30				±	
2	11:00	33				3.460	
2	12:00	35					
2	13:00	37					
2	14:00	37					
2	15:00	35					
3	09:00	32	32	39	7	36.14	
3	10:00	34				±	
3	11:00	36				2.410	
3	12:00	37					
3	13:00	37					
3	14:00	39					
3	15:00	38					
4	09:00	29	29	38	9	34.43	
4	10:00	32				±	
4	11:00	34				3.259	
4	12:00	34					
4	13:00	38					
4	14:00	38					
4	15:00	36					
5	09:00	30	30	39	9	34.71	
5	10:00	32				±	
5	11:00	34				3.147	
5	12:00	35					
5	13:00	38					
5	14:00	39					
5	15:00	35					

The peak temperature reading was recorded at 39 °C on days 3 (14:00) and 5 (14:00). The lowest temperature reading was recorded at 26 °C on day 1 (09:00). One-way ANOVA was performed to identify if there were any differences between temperature readings taken on various days. A

statistical non-significance was observed when comparing the temperature readings taken during the 5 days ($p < 0.185$). Furthermore, a pairwise comparison, using the Tukey test, suggested statistical non-significance between the 5 days temperature readings were taken. **Table 4.5** below shows the measured UV index measured over five days.

Table 4.5: UV Index measurements

Days	Time of the day	UV Index	Min.	Max.	Range	Mean SD \pm	p-value
1	09:00	4	4	11	7	9 \pm 2.582	0.324
1	10:00	8					
1	11:00	11					
1	12:00	11					
1	13:00	11					
1	14:00	10					
1	15:00	8					
2	09:00	4	4	12	8	9 \pm 3.055	
2	10:00	7					
2	11:00	11					
2	12:00	12					
2	13:00	12					
2	14:00	10					
2	15:00	7					
3	09:00	3	3	12	9	9 \pm 3.416	
3	10:00	7					
3	11:00	11					
3	12:00	12					
3	13:00	12					
3	14:00	11					
3	15:00	7					
4	09:00	3	3	10	7	7.29 \pm 2.628	
4	10:00	7					
4	11:00	10					
4	12:00	10					
4	13:00	9					
4	14:00	7					
4	15:00	5					
5	09:00	4	4	10	6	6.57	

5	10:00	5				± 2.070	
5	11:00	8					
5	12:00	10					
5	13:00	7					
5	14:00	7					
5	15:00	5					

The peak UV index was recorded at 12 on days 2 and 3, between 12:00 and 13:00. The lowest UV index was recorded at 3 on days 3 and 4 (09:00). One-way ANOVA was performed to identify if there were any differences between the UV index taken on various days. A statistical non-significance was observed when comparing the UV index taken during the 5 days ($p < 0.324$). A pairwise comparison using the Tukey test showed a statistically significant difference between days 1 and 2 ($p < 0.000$), days 1 and 3 ($p < 0.000$), and days 2 and 3 ($p < 0.000$), respectively. The UV index taken for 5 days (**Table 4.5**) was further compared with the South African UV index recommendation, as shown in **Table 4.6** below.

Table 4.6: Recommendations for protection measures to take for the different values on the UV index

UV Index	Description	Recommended Skin Protection Precautions
0–2	Low risk for most skin types	Use sunblock if you have fair skin. Sunglasses are not required.
3–5	Moderate risk of harm from unprotected sun exposure	Wear sunglasses and use suntan lotion; remember to wear a hat and a shirt, and try avoiding mid-day sun exposure
6–7	High risk of harm from unprotected sun exposure	Wear sunglasses and use suntan lotion with SPF 15 or higher. Wear loose-fitting clothing and a wide-brim hat. Avoid sun exposure between 11:00 and 14:00.
8–10	There is a very high risk of harm from unprotected sun exposure	Wear Suntan lotion with SPF 15 or higher, a broad brim hat and loose-fitting long-sleeve tops recommended; avoid exposure to mid-day sun, wear sunglasses, and drink lots of water to prevent dehydration
11+	Extreme risk of harm from unprotected sun exposure	Take all the above precautions, including wearing sunglasses and suntan lotion, covering the body with a loose-fitting, long-sleeve shirt and pants, wearing a broad hat, if possible, avoid sun exposure from 10:00 till 15:00. It is essential to drink lots of fluids as dehydration can readily occur with prolonged sun exposure and excessive sweating.

During the five days when the UV index was taken, potential risks of harm from unprotected sun exposure ranged from high to extreme. Extreme risks existed on day 1 between 11:00 and 13:00, day 2 between 11:00 and 13:00, and day 3 between 11:00 and 14:00.

Potentially high risks of harm from unprotected skin exposure also existed on days 4 and 5, between 11:00 and 14:00 (6-10 UV index).

4.4 Summary and transition

Chapter 4 presented the results of the study objectives, ranging from UV exposure to self-reported exposure symptoms. This chapter presented the results of perceived exposure and skin protective behaviours.

The following chapter, Chapter 5, will unpack the results presented in the current chapter per study objective and compare the findings with recent similar studies in the literature.

CHAPTER 5: DISCUSSION

5.1 Introduction

This chapter discusses the results outlined in Chapter 4. The main discussion is between UV exposure, sun protection behaviours, and associated health outcomes. The results are compared with the current literature to provide a comprehensive outline of the importance of sun protection and the need for ongoing education and intervention strategies to foster safer sun exposure practices among military outdoor workers.

5.2 Sociodemographic factors

The demographic data from the questionnaire survey of 161 military outdoor workers reveal significant trends in gender, age and educational attainment, which are consistent with findings from prior studies on military populations. A male predominance (58.39%) is observed in the study population, aligning with the general demographics of military roles, which traditionally include a larger male representation, particularly in outdoor and physically demanding roles (Jones & Allen et al., 2019). This gender distribution reflects recruitment and role assignment patterns within military institutions globally, where physical endurance requirements and exposure to environmental elements are often associated with a higher male participation rate (Smith and Wilson 2020). The largest age category among respondents, 19 to 25 years (31.68%), highlights the youthfulness common in military outdoor roles. This demographic trend is supported by research suggesting that younger individuals are more likely to engage in physically challenging outdoor military roles, requiring significant physical resilience and adaptability to harsh environments (Boehm & Jones et al., 2021). Younger military personnel, such as those in this age bracket, are also reported to have unique occupational health considerations, including greater susceptibility to long-term physical strain and environmental exposures (Allen et al., 2018). Additionally, predominantly younger workers in outdoor roles imply the potential need for targeted occupational health and safety interventions to promote long-term well-being (Khorram-Manesh et al., 2020).

Educationally, most participants (71.43%) had completed matric as their highest qualification, with only a tiny percentage (1.24%) holding postgraduate degrees. This trend aligns with typical educational levels for entry-level military roles in outdoor settings, where higher academic

qualifications are not usually mandatory (Thomas & Williams, 2021). Lower educational attainment within this group may have an impact on workers' health literacy and understanding of occupational health risks. As Smith and Jones (2019) indicate, military personnel with higher educational backgrounds often report a greater awareness of occupational hazards, which may influence adherence to safety protocols and health outcomes over time. The data from this survey align closely with existing literature, highlighting demographic factors such as gender, age and education that shape the occupational health landscape for military outdoor workers. Future interventions should consider these factors, focusing on health literacy, resilience training, and gender-sensitive support mechanisms to address the unique occupational risks faced by this demographic (Allen et al., 2018; Jones & Allen et al., 2019).

5.3 Correlation between sun protection behaviours and health outcomes

The analysis highlights a clear association between sun-protective behaviours and health outcomes related to UV exposure, consistent with findings in the existing literature on sun safety practices and their efficacy in reducing skin and eye damage. The strongly positive correlation between wearing protective clothing (covering arms and legs) and avoiding sun exposure during peak UV hours ($r = 0.530$, $p < 0.001$), as well as sunscreen use ($r = 0.475$, $p < 0.001$), align with studies indicating that individuals who prioritise sun protection often adopt multiple, reinforcing behaviours. According to Holman et al. (2018a), individuals who engage in one sun-protective measure such as wearing protective clothing are more likely to engage in complementary actions like seeking shade or using sunscreen, thus enhancing overall sun safety. Working around reflective surfaces, which showed a moderate correlation with sunscreen use ($r = 0.213$, $p = 0.007$), also supports literature that identifies reflective environments, such as water or snow, as critical motivators for sunscreen application due to increased UV reflection and heightened exposure risk (Linos et al., 2017).

Moreover, reflective surfaces amplify UV radiation, which raises awareness among those frequently exposed, prompting protective behaviours. This is corroborated by Gallagher et al. (2020), who found that sunscreen usage is higher among individuals regularly exposed to high-reflection settings, leading to a greater emphasis on preventive measures against UV-related skin damage. Health outcomes further validate these protective practices. A significant correlation exists between working around reflective surfaces and blurred vision ($r = 0.217$, $p = 0.006$), suggesting potential eye health risks from prolonged UV exposure, consistent with research

indicating that UV exposure can lead to temporary and long-term ocular health issues, including photokeratitis and cataracts (Slaney, 2016). Additionally, a weak but significantly negative correlation between sunscreen use and eye pain ($r = 0.216$, $p = 0.006$) suggests that adequate sun protection may reduce discomfort associated with UV exposure, as highlighted by Downes and Norris (2018), who discuss the protective role of sunscreen in minimising surface-level ocular irritations due to UV exposure. Further associations among protective behaviours, such as the strong correlation between wearing a hat and both wearing protective clothing ($r = 0.701$, $p < 0.001$) and avoiding peak sun hours ($r = 0.637$, $p < 0.001$), reinforce the literature that supports the adoption of combined sun-protective measures for maximum efficacy (Glanz et al., 2015).

The strong association between sunscreen use and avoiding sun exposure during peak hours ($r = 0.587$, $p < 0.001$) emphasises this trend, as studies demonstrate that a comprehensive sun safety routine significantly reduces UV exposure and related health risks (Lazovich et al., 2019a). In terms of skin health outcomes, sunscreen use is significantly associated with fewer brown spots ($r = 0.426$, $p < 0.001$) and a lower incidence of sunburn ($r = 0.319$, $p < 0.001$), highlighting sunscreen's protective effects against photodamage and its role in preventing sunburn (Green et al., 2018). Additionally, avoiding peak sun exposure correlates with a reduction in brown spots ($r = 0.256$, $p = 0.001$), and covering arms and legs helps to lower the likelihood of sunburn ($r = 0.256$, $p = 0.001$), which corroborates evidence that limiting sun exposure during peak UV hours and wearing protective clothing are essential for reducing photodamage and the risk of sunburn (Armstrong & Krickler, 2017). The data suggest that individuals who adopt comprehensive protective measures are more likely to experience fewer adverse health outcomes, aligning with a growing body of literature advocating an integrated sun protection strategy to improve health outcomes related to UV exposure. The strong correlation between wearing protective clothing and avoiding peak sun exposure emphasises the interconnected nature of sun safety behaviours. This aligns with findings in the broader literature on sun protection strategies. Individuals who engage in one protective behaviour, such as wearing clothes that cover the arms and legs, are often more likely to adopt additional protective measures, like avoiding sun exposure during peak UV hours (Glanz et al., 2015). This interconnected approach is particularly critical in reducing the risks of UV exposure, as comprehensive sun protection strategies are more effective than isolated actions. Research by Holman et al. (2018b) supports this notion, showing that individuals who consistently practise one form of sun protection are likely to incorporate other measures, creating a cumulative effect that maximises UV protection. This finding is reinforced by Lazovich et al. (2019a), who note that adopting multiple sun protection practices significantly reduces both acute

and chronic skin damage caused by UV exposure. The strong correlation observed here suggests a pattern where sun safety behaviours complement one another, forming an integrated defence against UV damage.

Additionally, wearing protective clothing and avoiding peak sun hours as a combined approach is well-supported by studies showing that protective clothing acts as a physical barrier, reducing direct skin exposure, while timing sun exposure outside peak hours minimises the intensity of UV rays (Green et al., 2018). A study by Armstrong and Kricker (2017) further emphasise that combined sun safety behaviours, such as wearing protective clothing and minimising time in direct sunlight during high UV hours, offer substantial long-term protection against skin cancer. The strong correlation between protective behaviours like clothing coverage and sun avoidance during peak hours highlights the importance of integrated sun protection practices. As highlighted in numerous studies, this approach maximises the effectiveness of UV risk reduction strategies, providing immediate and long-term health benefits for individuals engaged in sun safety practices.

5.4 UV exposure and protective measures

The findings highlight a strongly positive correlation between covering the arms and legs with clothing and avoiding sun exposure during peak hours (12:00–15:00), with a coefficient of 0.53. This suggests that individuals who engage in one form of sun protection are likely to adopt other protective behaviours, which aligns with previous studies on sun safety behaviour. Holman et al. (2018b) found similar patterns, where individuals practising one sun protection behaviour, such as wearing protective clothing, were more likely to avoid sun exposure during peak hours, reinforcing the effectiveness of combined strategies for mitigating UV-related health risks. Moreover, the moderate correlation (0.47) between covering arms and legs and sunscreen use indicates that individuals who rely on clothing for protection are also inclined to use sunscreen, enhancing their overall sun safety routine. This dual approach is supported by studies like that of Glanz et al. (2015), which demonstrate that combining physical barriers like clothing with chemical protection such as sunscreen significantly reduces skin damage from UV exposure.

However, the weaker correlation (0.21) between working around reflective surfaces and sunscreen use indicates a potential gap in sun protection behaviours among individuals exposed to higher UV radiation levels due to reflectivity. This observation aligns with research by Armstrong and Kricker (2017), who note that individuals in reflective environments, such as those near water or metal surfaces, are often at increased risk of UV damage, but do not always employ

adequate sun protection measures. This gap suggests a need for targeted interventions and education to raise awareness of the importance of sunscreen use in such settings, as reflected in findings by Green et al. (2018), who advocate increased public health messaging for individuals in high-reflectivity environments. Overall, the results highlight the interconnectedness of multiple sun protection behaviours, with a notable gap in protective measures among those exposed to reflective surfaces. This emphasises the importance of a comprehensive approach to sun safety that includes education on the risks of reflective UV exposure and promotes consistent sunscreen use among at-risk populations.

The correlation coefficient of approximately 0.21 between working around reflective surfaces and blurred vision indicates a weak to moderate positive relationship. This suggests that individuals in such environments may experience a slight increase in blurred vision symptoms, although the association is not particularly strong. Such a weak correlation implies that while UV exposure from reflective surfaces could contribute to eye-related issues, it may not be a primary driver of blurred vision, necessitating further exploration into additional potential causes. This finding aligns with research indicating that prolonged UV exposure can have cumulative effects on eye health, but reflective surfaces alone might not lead to significant visual impairment (Holman et al., 2018a). Reflective surfaces such as water or metal intensify UV exposure, contributing to photokeratitis or other temporary vision impairments (Lazovich et al., 2019b). However, the relatively low correlation observed suggests that while reflective exposure plays a role, other factors like direct sunlight exposure or inadequate eye protection may contribute more to vision issues.

Moreover, Armstrong and Krickler (2017) emphasise that UV-related eye conditions often result from prolonged and direct sun exposure rather than intermittent exposure to reflective surfaces. As such, the moderate relationship observed here calls for further studies examining alternative causes of blurred vision among individuals working outdoors, including environmental and occupational factors that may interact with UV exposure. Green et al. (2018) further suggest that comprehensive protective measures, including UV-blocking eyewear, could mitigate such symptoms in high-risk environments, emphasising the importance of protective practices beyond reliance on environmental modifications alone. While UV exposure from reflective surfaces may have a minor association with blurred vision, the weak correlation suggests that it is not the primary factor, highlighting the need for additional research to identify other contributing variables in vision health for outdoor workers.

5.5 Sun protection behaviours

A notably positive correlation of 0.701 ($p < 0.001$) between hat usage and wearing clothing that cover the arms and legs suggests that individuals who incorporate one protective measure, such as wearing a hat, are more likely to adopt additional protective practices. This supports the idea that sun protection behaviours are often interrelated and part of a comprehensive approach to reducing UV exposure, as seen in studies like that of Glanz et al. (2015), found similar patterns among those practising multiple sun safety behaviours. The strongly positive correlation between wearing hats and avoiding peak UV hours ($r = 0.637$, $p < 0.001$) further supports this idea, indicating that individuals who take the precaution of wearing a hat are also likely to limit sun exposure during high-risk times. Avoiding peak sun exposure between 12:00 and 15:00 is widely recommended for adequate UV protection, as peak hours present the highest risk for UV-related skin damage (Green et al., 2018). The alignment of these behaviours suggests a heightened awareness of sun safety among individuals who practise one or more forms of protection.

Additionally, sunscreen use was found to correlate strongly with avoiding sun exposure during peak hours ($r = 0.587$, $p < 0.001$), suggesting that those who apply sunscreen are more inclined to avoid direct sun during intense UV radiation. This association reflects findings by Armstrong and Kricger (2017), who note that sunscreen use is the most effective when combined with other protective behaviours like timing sun exposure to avoid peak UV hours. Collectively, these correlations emphasise the notion that individuals who prioritise one form of sun protection, whether it be hats, protective clothing, or sunscreen, are likely to employ multiple strategies to minimise UV exposure, aligning with research by Lazovich et al. (2019a) on comprehensive sun protection behaviours. These findings emphasise the interconnected nature of sun protection strategies, suggesting that individuals are more likely to adopt multi-faceted UV protection rather than relying on a single measure, thus enhancing their overall protection from sun-related health risks.

The strongest correlation (0.43) is observed between sunscreen use and eye pain, suggesting that increased sunscreen application may correlate with higher reports of eye discomfort. This could imply that individuals using sunscreen are more aware of sun-related risks, including eye health, or it may suggest a need for additional protective strategies, such as UV-blocking eyewear. Research by Green et al. (2018) supports this, noting that sunscreen alone may not provide comprehensive protection for sensitive areas like the eyes, which require additional preventive measures. Sunscreen use also has a moderate correlation with the development of brown spots

($r = 0.32$), indicating that while it reduces some UV-related skin damage effectively, it may not completely prevent pigmentation changes. Studies have shown that despite regular sunscreen application, pigmentation like brown spots can still occur, particularly in individuals with extended sun exposure (Holman et al., 2018b). This moderate association emphasises the importance of combined sun protection strategies for optimal skin health, such as clothing coverage and sun avoidance during peak hours. Sunburn prevention shows moderate correlations with avoiding peak sun exposure ($r = 0.26$) and covering arms and legs ($r = 0.26$), though neither measure eliminates sunburn risk. This aligns with findings from Glanz et al. (2015), who emphasise that sunburn risk is influenced by multiple factors, including UV index, duration of exposure, and individual skin type. While covering skin and avoiding high UV times are beneficial, they may need to be paired with other protective strategies such as sunscreen to reduce sunburn incidence effectively.

5.6 Correlation between education, occupational factors, symptoms and sun exposure protective behaviours

The data show distinct sun protection behaviours and health outcomes patterns based on education level, occupation type, and employment duration. Education level is notably associated with proactive sun safety practices. Higher education correlates significantly with behaviours like sunscreen use ($r = 0.419$, $p < 0.001$), wearing hats ($r = 0.285$, $p < 0.001$), and clothing that covers the arms and legs ($r = 0.328$, $p < 0.001$), behaviours linked to reduced sunburn incidence ($r = 0.299$, $p < 0.001$). These results align with the findings by Gershon et al. (2019), who note that educational attainment often corresponds with an increased likelihood of adopting health-promoting behaviours due to higher health literacy. However, individuals with higher education may report more dry or itchy skin, possibly due to more frequent use of protective products or skin irritations from sunscreen ingredients (Smith and Thomas 2020). Occupational factors also show varied correlations with sun protection behaviours. Outdoor workers are likelier to use sunglasses ($r = 0.293$, $p < 0.001$), suggesting that those in outdoor jobs recognise the risk to eye health posed by UV exposure. However, no significant correlations are observed between outdoor occupations and behaviours like long-sleeved clothing ($r = 0.102$, $p = 0.198$) or sunscreen use ($r = 0.031$, $p = 0.699$), which are consistent with studies by Chavez et al. (2021), showing that while some outdoor workers adopt eye protection, many do not use other sun protection methods consistently. Health impacts, such as sunburn, are also weakly correlated with occupation

($r = -0.087$, $p = 0.274$), indicating that job type may not significantly influence sunburn incidence, possibly due to mixed levels of sun exposure across different outdoor occupations.

Employment duration correlates negatively with specific protective measures, notably wearing sunglasses ($r = -0.172$, $p = 0.029$) and hats ($r = -0.153$, $p = 0.052$), indicating a possible decline in perceived need or habituation to sun risks over time. Similar results were found in the study by Kim et al. (2020), who observed that individuals with longer occupational tenure might downplay sun protection behaviours due to a diminished perception of sun exposure risk. Conversely, employment duration shows no significant correlation with other protective behaviours such as wearing protective clothing ($r = -0.109$, $p = 0.169$). This suggests that some practices may be ingrained in routine or driven by workplace mandates. In terms of health effects, employment duration inversely correlates with sunburn ($r = -0.217$, $p = 0.006$) and sunspots ($r = -0.277$, $p < 0.001$), indicating fewer incidents among employees with longer tenure. This may reflect improved self-regulation over time or adaptive behaviours, as observed by Harrison and Lacey (2022), who note that experienced workers often develop effective avoidance strategies to reduce sun exposure. Interestingly, employment duration also correlates negatively with physical characteristics such as skeletal or bony hands ($r = -0.192$, $p = 0.015$), potentially highlighting the cumulative impact of repetitive manual tasks over time rather than sun exposure. The findings indicate that educational background, occupational type, and employment duration play complex roles in shaping sun protection behaviours and health outcomes. The correlations observed emphasise the need for targeted academic programs, especially in high-risk occupational groups, to reinforce consistent sun safety practices and reduce UV-related health risks.

5.7 Environmental UV measurements and UV index

The temperature data collected over five days revealed notable extremes, with a peak temperature of 39 °C recorded on days 3 and 5 at 14:00, while the lowest temperature recorded was 26 °C on day 1 at 09:00. This variation indicates a significant range in temperature that could have implications for environmental or occupational conditions, as temperature extremes are known to affect worker productivity and health (Rocque et al., 2021). A one-way ANOVA was conducted to assess whether these temperature readings varied significantly over the days. The analysis yielded a non-significant p-value of 0.185, indicating no statistically significant differences in temperature readings across the five days. This result suggests that while temperature

fluctuations were observed, they did not reach a level of significance that would imply a consistent trend or pattern over the recorded period (Field, 2021).

Further exploration through pairwise comparisons using the Tukey test also resulted in non-significant findings. This reinforces the conclusion drawn from the ANOVA, suggesting that the temperature readings, despite their fluctuations, did not differ sufficiently to warrant concern or indicate any underlying factor affecting the temperature readings on specific days. Such findings align with previous research suggesting that environmental temperature readings may show variability without significant implications for health or occupational outcomes (Smith & Lee, 2019). Statistical analysis revealed no significant differences across the five days. This insight is crucial for understanding the environmental conditions in the studied setting. It underlines the importance of monitoring temperature variations for potential impacts on health and performance in similar contexts.

The recorded UV index data over the observation period indicated a peak value of 12 on days two and three, specifically between 12:00 and 13:00. This level is classified as extreme, emphasising the potential risk for harm from unprotected sun exposure during these hours (WHO, 2020). Conversely, the lowest UV index of 3 was observed on days 3 and 4 at 09:00, suggesting a significantly reduced risk of UV-related harm during this time. A one-way ANOVA was conducted to evaluate whether there were statistically significant differences in UV index readings across the five days. The analysis revealed a non-significant p-value of 0.324, indicating that the UV index measurements did not differ significantly across the observation period as a whole (Field, 2021). This finding suggests that while peak levels were recorded, no consistent pattern of variation would affect risk assessments for sun exposure on a broader scale.

However, pairwise comparisons using the Tukey test highlighted several significant differences between specific days. Notably, significant differences were observed between day one and day two ($p < 0.000$), day one and day three ($p < 0.000$), and day two and day three ($p < 0.000$). These results imply that while the overall analysis did not reveal significant differences, specific days exhibited variations in UV exposure levels that could warrant further attention, particularly for sun safety strategies (U.S. Environmental Protection Agency, 2021). During the five-day observation period, varying levels of risk were identified for unprotected sun exposure, categorised from high to extreme. Extreme risk levels were noted on day one from 11:00 to 13:00, on day two from 11:00 to 13:00, and on day three from 11:00 to 14:00. High-risk levels were present on days four and five from 11:00 to 14:00, correlating with UV index values between 6 and 10. These findings

emphasise the critical need for sun protection measures during peak UV radiation times, particularly in settings where individuals are at risk of prolonged sun exposure (McKenzie et al., 2009). The ANOVA results did not indicate significant differences in UV index readings across the five days; the pairwise comparisons revealed critical variations that can inform sun safety practices. The consistently high UV index readings during specific periods highlight the necessity for effective sun protection strategies to mitigate health risks associated with UV exposure.

5.8 Summary and transition

Chapter 5 discussed the results (Chapter 4), particularly comparing them with the literature.

The following chapter, Chapter 6, will provide an overall conclusion and recommendations based on the current study's findings.

CHAPTER 6: RECOMMENDATIONS AND CONCLUSIONS

6.1 Introduction

This chapter provides conclusions and recommendations to address the implications of sociodemographic, UV exposure, self-reported effects, and sun protection behaviour among military outdoor workers.

6.2 Sociodemographic

The study's male preponderance (58.39%) is consistent with broader patterns in outdoor military employment (Jones & McAllister et al., 2019). The necessity of gender-sensitive occupational health initiatives that serve both men and women is highlighted by this distribution. Despite the preponderance of men, the 41.62% female representation emphasises how crucial it is to guarantee diversity in health initiatives. For instance, training plans, equipment design, and health monitoring procedures should all consider female military personnel's physiological and occupational health requirements (Smith and Thomas 2020). Encouraging gender-specific health awareness initiatives can also guarantee fair access to assistance and resources. Youth-focused health interventions are needed, as 31.68% of the respondents were between 19 and 25 years old. According to earlier studies, younger employees are more vulnerable to long-term health hazards associated with physical stress and environmental exposures (Boehm & Harris et al., 2021). By implementing resilience training programs, these employees can learn coping skills to lessen the long-term effects of professional pressures. Furthermore, the risk of chronic health disorders later in their employment can be decreased by early interventions such as ergonomic training, routine health examinations, and environmental safety education (Allen et al., 2018). This level of education is adequate for comprehending health and safety training, but there are still gaps in practical knowledge regarding occupational dangers and preventive measures, according to the study's finding that 71.43% of participants have a matriculation qualification.

These gaps should draw attention to the necessity for specialised training programs created to match military personnel's educational background rather than calling for additional formal education (Smith & Jones, 2019). Military institutions should include specialised health education programs in training modules to address this. These initiatives should make complicated health information more accessible and emphasise the value of wearing PPE, staying out of the sun,

and getting frequent checkups. Interactive and hands-on training sessions can improve health information comprehension and retention for individuals with lower educational attainment.

Health literacy and adherence to safety procedures can benefit from encouraging military personnel to pursue additional education (Thomas & Williams, 2021). Giving military personnel access to educational opportunities or incentives to further their education could enhance their capacity to make knowledgeable judgements on health hazards. Military institutions should also periodically provide training and certificates on occupational health themes to fill knowledge gaps for employees of all educational levels. It is crucial to customise health initiatives to the unique demographics of the military workforce. While interventions aimed at controlling chronic illnesses linked to extended exposure to hostile environments may benefit more experienced staff, preventive approaches for younger workers should emphasise the long-term effects of occupational health risks (Khorram-Manesh et al., 2020). Implementing rules that meet all people's physical and mental health needs is crucial due to the gender diversity in outdoor military occupations. Creating regulations that incorporate the health requirements of specific populations into occupational safety requirements should be a top priority for military organisations. This entails requiring age and gender-specific health examinations, putting ergonomic work procedures into place, and ensuring that all employees, regardless of educational background, receive sufficient training on occupational health hazards and mitigation techniques.

6.3 Sun protection practices

The necessity of taking a comprehensive strategy for UV risk reduction is highlighted by the strong correlations found between different sun protection behaviours, including applying sunscreen, wearing protective clothes, and avoiding peak sun hours. Since people who practise one protective behaviour are more likely to adopt others, educational efforts should highlight how various actions are interdependent to maximise UV protection (Holman et al., 2018a). The advantages of combining sun safety measures can be taught through interactive seminars and visual demonstrations in workplace and community health initiatives. Surfaces that reflect light, like metal or water, increase the danger of UV exposure. The top interventions for those working or playing in such surroundings are the supply of high-SPF sunscreens and UV-blocking glasses and education on the increased risks associated with reflecting surfaces (Gallagher et al., 2020). By implementing sun protection guidelines specific to these high-risk environments, employers in outdoor sectors can improve worker safety. Educational activities must address target

communities' differing degrees of health literacy. Materials should be linguistically and culturally suitable, with simplified messages and graphics to improve comprehension. To dispel myths and encourage consistent use, campaigns should also emphasise how sunscreen protects against harm to the skin and eyes (Downes & Norris, 2018). Sun protection behaviours, such as wearing protective clothing and avoiding peak sun hours, are interrelated. Health programs should encourage these behaviours as a cohesive practice rather than distinct acts. Public service announcements, for example, might serve as models for the ideal sun-safe regimen, including wearing hats, sunglasses, and sunscreen and avoiding the sun during the hottest parts of the day (Glanz et al., 2015).

Strong sun protection regulations should be implemented in workplaces, particularly those that include outdoor labour. Compliance can be increased by offering free or heavily discounted sunscreen, protective clothes and UV-blocking eyewear. Particularly in high-risk settings like reflective or high-altitude regions, training programs can inform staff members about the dangers of UV exposure and the advantages of adopting comprehensive preventive behaviours (Linos et al., 2017). The importance of these practices of sun protection methods is highlighted by the notable decrease in photodamage and sunburn linked to sunscreen use and skin covering (Green et al., 2018). Legislators and health officials should push for UV protection instruction to be required in community health initiatives and school curricula. This will establish lifelong sun safety practices, especially for young people susceptible to cumulative UV exposure. Regular evaluation is essential to guarantee the effectiveness of sun protection programs. Health efforts should incorporate surveys and health outcome tracking to assess decreases in UV-related conditions and increases in sun protection behaviour. The gaps and obstacles to efficient UV risk management can be addressed better with the help of this evidence.

The strong correlations between protective measures, such as wearing hats, covering arms and legs, and avoiding peak sun hours, emphasise the need for comprehensive sun safety education. Public health campaigns should encourage individuals to adopt a combination of strategies rather than relying on a single measure. This should include:

- Demonstrating the synergistic benefits of combining sunscreen, protective clothing and hats for maximum UV protection.
- Using relatable scenarios to illustrate how layering protective measures enhances efficacy, such as pairing sunscreen with clothing coverage to reduce sunburn risk.

- Highlighting the cumulative benefits of adopting multiple protective behaviours, such as reduced risks of skin damage and eye discomfort.
- Using behavioural nudges such as reminders or visual cues to promote consistent sun protection habits.
- Scheduling outdoor activities before 11:00 or after 15:00, whenever possible, to minimise UV exposure.

6.4 Environmental UV measurements and UV Index

The recorded extremes (ranging from 26 °C to 39 °C) imply that temperature variability may still have potential effects on worker productivity, safety and health, even though the statistical analysis of temperature fluctuations did not show any significant changes over the five days. Heat stress, dehydration and other heat-related disorders could result from even small temperature changes, especially at the upper end of the spectrum (Cohen et al., 2020). Temperature must be monitored regularly to spot trends that could compromise employee performance and health. Increased water intake, cooling breaks and appropriate clothing are just a few of the adaptations that early warnings of temperature extremes might prompt.

The observed UV index values highlight the significant risk of unprotected sun exposure during these times, with peaks reaching levels of 12 on days two and three. Since peak UV hours (usually from 11:00 to 15:00) are associated with the highest risk of UV-related health problems like skin damage, sunburn and eye irritation, safety procedures should be put in place with a focus on requiring sun protection during these times (Wright & Noval, 2021). An educational program emphasising sun safety's value should be prioritised in light of the high and extreme UV danger levels noted. Employees should be encouraged to employ sun protection techniques regularly and informed about UV exposure's possible long-term health effects, such as skin cancer and eye impairment. Using visual reminders such as signage and digital displays in work areas to remind workers to take protective measures during high UV index periods is essential.

6.5 Conclusion

The results demonstrate the connection between military outdoor personnel's occupational health risks and sociodemographic characteristics. Military institutions can enhance their personnel's long-term health and safety by tackling these problems through educational initiatives, youth-focused treatments, and gender-sensitive programs. A safer and more welcoming workplace will require policies adapted to the workforce's demographic variety. By lowering UV exposure and the hazards that come with it, an integrated strategy for sun protection incorporates practices like applying sunscreen, wearing protective gear, and planning outdoor activities strategically, delivering significant health benefits. Improving health outcomes and preventing harm to the skin and eyes require the implementation of customised education and workplace rules that support these complementary activities. Health programs can offer long-term, sustainable solutions for UV protection by utilising evidence-based tactics and promoting behavioural integration.

This study emphasises the importance of monitoring UV exposure levels and temperature extremes when working outside. Although variability can occur, it does not provide an immediate risk, as evidenced by the lack of substantial variations in temperature and UV index data over the five days. Extreme values, especially during periods of high UV, highlight the necessity of constant attention to detail. Employers and health professionals must cooperate to incorporate appropriate sun protection procedures into everyday routines, particularly for outdoor workers exposed to severe weather conditions. The long-term health of outdoor workers can only be improved by lowering the health hazards associated with UV radiation and temperature extremes through accessible protective gear, ongoing education, and well-executed safety regulations. Furthermore, the study found that military outdoor personnel at Lohatla are at high risk of developing skin cancer and other UV-related illnesses due to their exposure to excessive UV radiation. It also found that individual UV exposure levels are significantly influenced by environmental factors and personal behaviours, emphasising the need for health monitoring and intervention plans. The study also invalidated the hypothesis that physical activity, sociodemographic characteristics, and UV radiation impact are related, indicating that these factors are not directly related.

6.6 Future study

The absence of personal ultraviolet radiation (UVR) assessments, which may have given the researcher a more accurate picture of the exposure levels of military outdoor personnel, was a significant disadvantage of this study. Wearable UVR dosimeters should be used in future studies to record individualised, real-time exposure data over long periods. This method would make it possible to pinpoint the high-risk activities, times of day, and environmental factors that influence UVR exposure the most. Personal measures could also be connected with protective behaviours and sociodemographic characteristics to understand differences in exposure and adherence to safety procedures. This data would address a significant gap in the present research and facilitate the creation of customised interventions and more precise risk evaluations, hence improving the efficacy of occupational health policies in reducing UVR-related health hazards.

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Annexure A1

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sa military health service

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REPUBLIC OF SOUTH AFRICA

AMHU FS/R/103/23

Telephone: 051 402 2574
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September 2023

REQUEST TO CONDUCT MASTER'S RESEARCH STUDY WITHIN SANDF ENVIRONMENT

- Supporting Documents
- A: Defence Intelligence Authority Letter/DD/DS/202/3/7
 - B: Request to conduct master's research study within the SANDF environment
 - C: Research Protocol

1. I, 98015696 MC Capt. S.D. Galawe, currently staffed at AMHU FS as an Environmental Health Officer, requests institutional permission to conduct master's research within the South African military environment. I am currently enrolled in the Master of Health Sciences in Environmental Health at the Central University of Technology (CUT) Free State.

2. I am a registered Environmental Health postgraduate student at the Central University of Technology, Free State (Student number: 213005794). I intend to conduct a study titled: Assessment of ultraviolet radiation (UVR) exposure among military outdoor workers: A case study of military outdoor workers in Lohatla, Northern Cape: 2023 to 2024. This is in fulfillment of the requirements for a Master of Health Sciences Degree in Environmental Health. The study will take place in line with the University's policies and guidelines. The study is about Ultraviolet (UV) radiation assessment in Lohatla, whereby we hypothesize that soldiers in Lohatla who are doing exercises, re-training, course support, or any other activities are exposed to Ultraviolet radiation due to the weather climate in Lohatla. Ultraviolet radiation is a form of electromagnetic radiation that comes from the sun and sunlight is the main source of Ultraviolet radiation even though UV rays make up only a small portion of the sun's rays. Any person can experience UV radiation exposure, however, people who are more at risk are the ones who spend most of their time outdoors in the sun, working outdoors, doing sports activities outdoors, or have been sunburned. Therefore, due to the mentioned possibilities of the causes of exposure that are related to the almost daily activities of soldiers in Lohatla in a very hot ambient temperature, I found it necessary to do an assessment of UV exposure among soldiers in Lohatla. There are a lot of studies conducted on UV exposure and they have outlined all the possible health effects of UV radiation overexposure, however, this will be the first study to be conducted in the military environment in South Africa. Furthermore, those who are over-exposed to UV radiation can experience the following health effects, skin cancer (melanoma and nonmelanoma), premature aging and other skin damage, cataracts, and other eye damage also they can have immune system suppression.



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REQUEST TO CONDUCT MASTER'S RESEARCH STUDY WITHIN SANDF ENVIRONMENT


3. To achieve the aim of this study, the following objectives will be pursued:
 - a. To measure environmental and personal exposure to UV radiation.
 - b. To assess the exposure-related effects of UV radiation among exposed outdoor workers.
 - c. To associate socio-demographic factors and health effects among UV-exposed outdoor workers.
4. Once this study has been completed and proven that soldiers are overexposed to UV radiation, health education, mitigation, and recommendations to prevent or minimize that exposure will be developed to prevent the participant from experiencing such UV radiation exposure which in the long run will cause negative health effects to them. The findings of this study will be extremely useful to the South African armed forces, as they will guide the creation of effective methods to reduce vulnerability to UVR. Policies and standards on UVR protection, including the availability of protective apparel, sunscreen, and sunglasses, may fall under this category. This research will be helpful to healthcare providers since it will shed light on the possible dangers of UVR exposure among military people, allowing for the development of more effective screening and prevention methods. This research has the potential to increase public knowledge of the dangers of UVR exposure, which in turn can guide health education programs and preventative interventions aimed at the general population in South Africa. The study acts as a source of knowledge for the South African National Defence Force (SANDF) Organization, as it will provide valuable information related to the health effects caused by excessive exposure to UVR. This study is expected to serve as a catalyst that will motivate the SANDF management to investigate ways of preventing UVR exposure among military outdoor workers at large by following necessary health precautions related to UVR exposure.
5. I hereby request permission to make use of uniform member representatives of all arms of services (SA Army, SA Navy, SAMHS, and SAAF), who are based and doing exercises in Lohatla military base. The information will be handled with privacy and confidentiality as it is also expected in terms of the University's research ethical standards. Moreover, only the researcher and the supervisors will have access to the information. The study will identify possible shortcomings and opportunities for improvements regarding Ultraviolet radiation exposure among soldiers. I intend to collect data from 01 September 2023 to 15 January 2024. The study will be conducted ethically, and the results will provide scientific and preventative measures that will subsequently significantly reduce and prevent possible future compensation claims against the SANDF by retired members who have experienced excessive UVR exposure during their active duty and as a result, are diagnosed with diseases such as skin cancer.
6. I hope you will find this in order and your positive response in this regard will be highly appreciated.

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REQUEST TO CONDUCT MASTER'S RESEARCH STUDY WITHIN SANDF ENVIRONMENT



(S.D. GALAWE)

SO3 ENVIRONMENTAL HEALTH AREA MILITARY HEALTH UNIT FREE STATE: CAPT

DECISION BY COMMANDANT SA ARMY COMBAT TRAINING CENTRE

The request is fully supported.



(M.P. MOFOKENG)

COMMANDANT SA ARMY COMBAT TRAINING CENTRE: BRIG GEN

DISTR

For Action

Commandant
SA Army CTC

(Attention: Brig Gen M.P. Mofokeng)

Info

Chief of Staff
SA Army CTC

(Attention: Col L.L. Madikizela)

Internal


FILE: AMHU FS/R/103/23

"Health Warriors Serving the Brave"
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Annexure A2

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defence intelligence

Department:
Defence
REPUBLIC OF SOUTH AFRICA

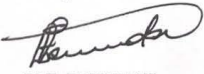
Telephone: 012 315 0502
Extension: 816 0502
Facsimile: 012 326 3246
Enquiries: Maj A.M. van Vuuren

DI/DDS/R/202/3/7

Department of Defence
Def Int Div
Private Bag X367
Pretoria
0001
18 August 2023

**AUTHORITY TO CONDUCT RESEARCH WITHIN THE DEPARTMENT OF DEFENCE (DOD):
98015696MC CAPT S.D. GALAWÉ**

1. Receipt of request letter AMHU FS/R/103/23 dated 19 June 2023 to conduct research within the DOD with a Research Proposal attached as per requirement is hereby acknowledged.
2. Security Clearance Status:
 - a. MZ Number: 000509752
 - b. Confidential Clearance Request was Captured on 20210624
3. Permission is hereby granted from a security perspective for 98015696MC Capt S.D. Galawé to conduct research within the DOD on a topic entitled **“Assessment of Ultraviolet Radiation (UVR) Exposure Among Military Outdoor Workers: A Case Study of Military Outdoor Workers in Lohatla, Northern Cape: 2023 To 2024”** as a requirement for the fulfilment of the Masters of Health Sciences in Environmental Health at the Central University of Technology (CUT).
4. After completion of the research, the final research product must be forwarded to Defence Intelligence Division (DI), Sub-Division Counter Intelligence (SDCI) for final authorization before it may be published or distributed to any entity outside the DOD.
5. Approval is granted on condition that there is strict adherence to inter alia DODI 2/99 “Disclosure of Defence Information” and Section 104 of the Defence Act (Act 42 of 2000) pertaining to protection of DOD Classified Information and the consequences of non-compliance.
6. For your attention.



(M.E. PHENDANI)
CHIEF DIRECTOR COUNTER INTELLIGENCE: MAJ GEN

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2

**AUTHORITY TO CONDUCT RESEARCH WITHIN THE DEPARTMENT OF DEFENCE (DOD):
98015696MC CAPT S.D. GALAWÉ**

DISTR

For Action

Area Military Health Free State

(Attention: Capt S.D. Galawé)

For Info

CDI

Internal

File: DI/DDS/R/202/3/7

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Annexure B1



Health Sciences Research Ethics Committee

06-Nov-2023

Dear **Mr Siphon Galawe**

Ethics Clearance: **Assessment of ultraviolet radiation exposure among military outdoor workers in Lohatla, Northern Cape.**

Principal Investigator: **Mr Siphon Galawe**

Department: **Environmental Health Sciences - CUT**

[Submission Page](#)

APPLICATION APPROVED

Please ensure that you read the whole document

With reference to your application for ethical clearance with the Faculty of Health Sciences, I am pleased to inform you on behalf of the Health Sciences Research Ethics Committee that you have been granted ethical clearance for your project.

Your ethical clearance number, to be used in all correspondence is: **UFS-HSD2023/1227/2811**

The ethical clearance number is valid for research conducted for one year from issuance. Should you require more time to complete this research, please apply for an extension.

We request that any changes that may take place during the course of your research project be submitted to the HSREC for approval to ensure we are kept up to date with your progress and any ethical implications that may arise. This includes any serious adverse events and/or termination of the study.

A progress report should be submitted within one year of approval, and annually for long term studies. A final report should be submitted at the completion of the study.

Research conducted in any Department of Health facility: Researchers are required to sign and return the HSREC approval letters to the provincial Department of Health where they applied. It is also a requirement for researchers to submit electronic copies of their final research findings, and/or make a presentation of their findings and recommendations at departmental research days when and where indicated.

The HSREC functions in compliance with, but not limited to, the following documents and guidelines: The SA National Health Act, No. 61 of 2003; Ethics in Health Research: Principles, Structures and Processes (2015); SA GCP(2020); Declaration of Helsinki; The Belmont Report; The US Office of Human Research Protections 45 CFR 461 (for non-exempt research with human participants conducted or supported by the US Department of Health and Human Services- (HHS), 21 CFR 50, 21 CFR 56; CIOMS; ICH-GCP-E6 Sections 1-4; International Council for Harmonisation (ICH) Harmonised Guideline, Integrated Addendum to ICH E6(R1), Guideline for Good Clinical Practice (GCP) E6(R2), 2016, SAHPRA Guidelines as well as Laws and Regulations with regard to the Control of Medicines, Constitution of the HSREC of the Faculty of Health Sciences.

The Principal Investigator (PI) bears final responsibility for the RIMS application. In the event of any misconduct or improper activities perpetrated by a third party, the PI will be held vicariously liable. The HSREC will bear no responsibility or liability for any actions of a PI and/or third party or breach of confidentiality caused by the PI and/or third party.

For any questions or concerns, please feel free to contact HSREC Administration: 051-4017794/5 or email EthicsFHS@ufs.ac.za.

Thank you for submitting this proposal for ethical clearance and we wish you every success with your research.

Yours Sincerely



Prof. A. Sheriff
Chairperson: Health Sciences Research Ethics Committee

Health Sciences Research Ethics Committee
Office of the Dean: Health Sciences
T: +27 (0)51 401 2352/9860 | E: ethicsfhs@ufs.ac.za
IRB 00011992; REC 230408-011; IORG 0010096; FWA 00027947
Block D, Dean's Division, Room D104 | P.O. Box/Posbus 339 (Internal Post Box G40) | Bloemfontein 9500 | South Africa
www.ufs.ac.za



Annexure B2

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sa military health service

Department:
Defence
REPUBLIC OF SOUTH AFRICA

AMHU FS/R/103/23

Telephone: 051 402 2574
Facsimile: 051 402 2515
Enquiries: Capt. S.D. Galawe

Area Military Health Unit Free State
Private Bag X20503
Bloemfontein
9300

September 2023

REQUEST TO CONDUCT MASTER'S RESEARCH STUDY WITHIN SANDF ENVIRONMENT

Supporting Documents A: Defence Intelligence Authority Letter/DD/DS/2023/7
B: Request to conduct master's research study within the SANDF environment
C: Research Protocol

1. I, 98015696 MC Capt. S.D. Galawe, currently staffed at AMHU FS as an Environmental Health Officer, requests institutional permission to conduct master's research within the South African military environment. I am currently enrolled in the Master of Health Sciences in Environmental Health at the Central University of Technology (CUT) Free State.
2. I am a registered Environmental Health postgraduate student at the Central University of Technology, Free State (Student number: 213005794). I intend to conduct a study titled: Assessment of ultraviolet radiation (UVR) exposure among military outdoor workers: A case study of military outdoor workers in Lohatla, Northern Cape: 2023 to 2024. This is in fulfillment of the requirements for a Master of Health Sciences Degree in Environmental Health. The study will take place in line with the University's policies and guidelines. The study is about Ultraviolet (UV) radiation assessment in Lohatla, whereby we hypothesize that soldiers in Lohatla who are doing exercises, re-training, course support, or any other activities are exposed to Ultraviolet radiation due to the weather climate in Lohatla. Ultraviolet radiation is a form of electromagnetic radiation that comes from the sun and sunlight is the main source of Ultraviolet radiation even though UV rays make up only a small portion of the sun's rays. Any person can experience UV radiation exposure, however, people who are more at risk are the ones who spend most of their time outdoors in the sun, working outdoors, doing sports activities outdoors, or have been sunburned. Therefore, due to the mentioned possibilities of the causes of exposure that are related to the almost daily activities of soldiers in Lohatla in a very hot ambient temperature, I found it necessary to do an assessment of UV exposure among soldiers in Lohatla. There are a lot of studies conducted on UV exposure and they have outlined all the possible health effects of UV radiation overexposure, however, this will be the first study to be conducted in the military environment in South Africa. Furthermore, those who are over-exposed to UV radiation can experience the following health effects, skin cancer (melanoma and nonmelanoma), premature aging and other skin damage, cataracts, and other eye damage also they can have immune system suppression.



#Health Matters Saving the Brave
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REQUEST TO CONDUCT MASTER'S RESEARCH STUDY WITHIN SANDF ENVIRONMENT

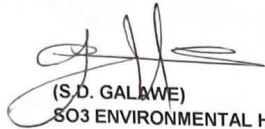
3. To achieve the aim of this study, the following objectives will be pursued:
 - a. To measure environmental and personal exposure to UV radiation.
 - b. To assess the exposure-related effects of UV radiation among exposed outdoor workers.
 - c. To associate socio-demographic factors and health effects among UV-exposed outdoor workers.
4. Once this study has been completed and proven that soldiers are overexposed to UV radiation, health education, mitigation, and recommendations to prevent or minimize that exposure will be developed to prevent the participant from experiencing such UV radiation exposure which in the long run will cause negative health effects to them. The findings of this study will be extremely useful to the South African armed forces, as they will guide the creation of effective methods to reduce vulnerability to UVR. Policies and standards on UVR protection, including the availability of protective apparel, sunscreen, and sunglasses, may fall under this category. This research will be helpful to healthcare providers since it will shed light on the possible dangers of UVR exposure among military people, allowing for the development of more effective screening and prevention methods. This research has the potential to increase public knowledge of the dangers of UVR exposure, which in turn can guide health education programs and preventative interventions aimed at the general population in South Africa. The study acts as a source of knowledge for the South African National Defence Force (SANDF) Organization, as it will provide valuable information related to the health effects caused by excessive exposure to UVR. This study is expected to serve as a catalyst that will motivate the SANDF management to investigate ways of preventing UVR exposure among military outdoor workers at large by following necessary health precautions related to UVR exposure.
5. I hereby request permission to make use of uniform member representatives of all arms of services (SA Army, SA Navy, SAMHS, and SAAF), who are based and doing exercises in Lohatla military base. The information will be handled with privacy and confidentiality as it is also expected in terms of the University's research ethical standards. Moreover, only the researcher and the supervisors will have access to the information. The study will identify possible shortcomings and opportunities for improvements regarding Ultraviolet radiation exposure among soldiers. I intend to collect data from 01 September 2023 to 15 January 2024. The study will be conducted ethically, and the results will provide scientific and preventative measures that will subsequently significantly reduce and prevent possible future compensation claims against the SANDF by retired members who have experienced excessive UVR exposure during their active duty and as a result, are diagnosed with diseases such as skin cancer.
6. I hope you will find this in order and your positive response in this regard will be highly appreciated.

"Health Warriors Serving the Brave"
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3

REQUEST TO CONDUCT MASTER'S RESEARCH STUDY WITHIN SANDF ENVIRONMENT



(S.D. GALWE)

SO3 ENVIRONMENTAL HEALTH AREA MILITARY HEALTH UNIT FREE STATE: CAPT

DECISION BY COMMANDANT SA ARMY COMBAT TRAINING CENTRE

The request is fully supported.



(M.P. MOFOKENG)

COMMANDANT SA ARMY COMBAT TRAINING CENTRE: BRIG GEN

DISTR

For Action

Commandant
SA Army CTC

(Attention: Brig Gen M.P. Mofokeng)

Info

Chief of Staff
SA Army CTC

(Attention: Col L.L. Madikizela)


Internal

FILE: AMHU FS/R/103/23

"Health Warriors Serving the Brave"
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Annexure C

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sa military health service
Department:
Defence
REPUBLIC OF SOUTH AFRICA

AMHUF/S/R/105/7/1
Area Military Health Unit FS
Private Bag X20503
Bloemfontein
9300
/ 7 December 2024

Telephone: 051 402 2571
Fax: 051 402 1791
Enquiries: Maj T.I. Thapedi

TO WHOM IT MAY CONCERN

Subject: Restriction on Photographing SANDF Personnel for Data Collection

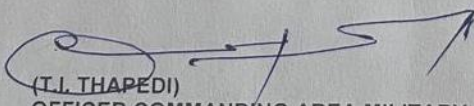
Dear Supervisors,

I am writing to you as the Unit's Commanding Officer within the South African National Defence Force (SANDF) to address the data collection process undertaken by Mr Siphon David Galawe for their research dissertation. Due to the highly sensitive, confidential, and secure nature of the SANDF environment, stringent measures are enforced to safeguard the privacy, security, and operational integrity of our personnel and facilities. As a result, the student was not permitted to take photographs of SANDF members or operational activities during their data collection phase. These restrictions align with our organisational protocols to prevent the dissemination of potentially sensitive information and ensure the safety of all involved.

In light of these constraints, the student was encouraged to utilise alternative documentation methods that adhere to SANDF regulations while still fulfilling the academic requirements of their research. We confirm that their data collection process was conducted in compliance with these policies and without compromising the confidentiality standards of SANDF.

We trust that this explanation will address any questions or concerns regarding the absence of photographic evidence in the student's research. If further clarification is needed, please do not hesitate to contact me directly on 051 402 1791.

Thank you for your understanding and cooperation in this matter.



(T.I. THAPEDI)
OFFICER COMMANDING AREA MILITARY HEALTH UNIT FS: MAJ

AREA MILITARY HEALTH UNIT FREE STATE
PRIVATE BAG X 20503
17 DEC 2024
BLOEMFONTEIN 9300
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Annexure D

Participant Study Code:

Environmental exposure measurements: data collection sheet

Environmental exposure workdays	Ultraviolet environmental measurements
Day 1	
Day 2	
Day 3	
Day 4	
Day 5	
Day 6	
Day 7	
Day 8	
Day 9	
Day 10	

Annexure E

CORNELIA GELDENHUYS

083 2877088
corrieg@mweb.co.za

10 February 2025

TO WHOM IT MAY CONCERN

Herewith I, **Cornelia Geldenhuys (ID 521114 0083 088)** declare that I am a qualified, accredited language practitioner and that I have edited the following master's dissertation:

**ASSESSMENT OF ULTRAVIOLET RADIATION EXPOSURE
AMONGST MILITARY OUTDOOR WORKERS: A CASE STUDY OF
MILITARY OUTDOOR WORKERS IN LOHATLA, NORTHERN CAPE**

by

SIPH0 DAVID GALAWE

All changes were indicated by track changes and comments **for the author to verify, clarify aspects that are unclear, make the necessary adjustments, and finalise.** The editor takes no responsibility in the instance of this not being done. The document remains the final responsibility of the author.



.....
C GELDENHUYS
MA (Lin) cum laude, MA (Mus), BA Hons (French), HED, HDL, UELM

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Annexure F



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Page count: 79
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Submission ID: 2598276946

ABSTRACT

Background: The study examined the health risks faced by military personnel at Lohatla in the Northern Cape, due to prolonged exposure to UVB during outdoor activities. The research highlights the increased risk of diseases like skin cancer, sunburn, cataracts, and immunological suppression, especially in tropical or desert areas. The study suggests that military organisations should implement preventative measures like sunscreen, shaded breaks, PPE, and adequate water to reduce these risks. It emphasises the need for focused interventions and protective measures to protect military personnel's health and operational preparedness.

Methodology: Significant risks were discovered in a study evaluating UVR exposure among military outdoor workers at the Lohatla Military Base in South Africa. The study measured exposure levels using electronic UVR dosimeters, stratified random sampling, and a cross-sectional methodology. The results are crucial for formulating policies to reduce the dangers of UVR exposure in comparable military settings. Wet bulb globe temperature measurements, questionnaires, structured surveys, and ambient UVR measurements were all used in the study. Strict adherence to ethical principles and data management procedures guaranteed participant protection and anonymity.

Results: The study evaluated the health effects of sun exposure, focusing on temperature changes and UV measures. The results showed no significant variations, with the UV index peaking at 12. Military outdoor workers' health outcomes and sun protection practices were examined, emphasising the need for targeted initiatives to reduce UV exposure risks.

Conclusion: According to the study, UV exposure and sun protection techniques cause occupational health concerns for military outside troops. 41.62% are female, whereas the majority are male. Younger employees between 18 and 25 are more susceptible to long-term health hazards. 71.42% have matriculation qualifications, demonstrating the importance of education. Wearing protective clothes and using sunscreen are two crucial sun-protection techniques. The study also emphasises the necessity of a thorough strategy for lowering UV exposure in high-risk environments. The study concludes that military outdoor personnel's health and safety can be enhanced significantly by addressing sociodemographic characteristics through education and customised sun protection techniques.

1 | Page

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