

**A Retrospective Review of Motor Vehicle Crashes during the 2022 December  
Festive Season in Namibia**

by

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Philosophy in the Faculty of Health Sciences at the University of Cape Town*

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## Table of Contents

Acknowledgements.....	4
List of Tables .....	5
List of Abbreviations.....	6
Part A: LITERATURE REVIEW .....	7
Road traffic injuries and the burden of disease .....	7
Global Burden of Disease .....	7
Burden of Disease in Africa.....	7
Road user vulnerability.....	10
Burden of Disease in Namibia.....	11
Ambulance distribution in Africa.....	12
Geospatial analysis of crashes .....	13
Cost of MVCs in Africa .....	14
Conclusion .....	16
References .....	17
Part B: MANUSCRIPT .....	20
Abstract.....	21
Introduction .....	23
Methodology .....	24
Study design.....	24
Setting and population.....	24
Data Collection .....	25
Data Analysis .....	25
Results.....	27
Crash characteristics.....	27
Patient Characteristics.....	30

Injuries.....	33
Medical Costs.....	33
Geospatial Analysis of Crashes.....	35
Discussion .....	36
Timing of crashes .....	36
Patient Characteristics.....	36
Injury Patterns .....	37
Geospatial Analysis.....	37
Medical Costs.....	38
Study Limitations.....	38
Conclusion .....	38
References .....	40
Part C: ADDENDA .....	42
Instructions to Authors.....	42
Research Protocol.....	43
HREC approval letter.....	59
Ministry of Health and Social Services Ethics Approval Letter .....	60
MVA Fund Approval Letter .....	61

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## List of Tables

Table 1. Number of crashes per region .....	27
Table 2. Crash distribution by day of week.....	28
Table 3. Distribution of sex and casualty status.....	30
Table 4. Patient person class .....	32
Table 5. Injuries sustained .....	33
Table 6. Medical cost per region .....	34

## List of Figures

Figure 1. Crash vs time of day .....	29
Figure 2. Crash peak days .....	30
Figure 3. Patient age groups .....	31
Figure 4. Injury class per region .....	32
Figure 5. December 2022 crashes in Namibia .....	35
Figure 6. Crash clusters in the country .....	35
Figure 7. Significant crashes in the country .....	35

## List of Abbreviations

DALY	Disability-Adjusted Life Years
ECC	Emergency Communications Centre
EMS	Emergency Medical Services
ESRI	Environmental Systems Research Institutes
GDP	Gross Domestic Product
GNP	Gross National Product
HIC	High Income Country
LMIC	Low and Middle Income Country
MoHSS	Ministry of Health and Social Services
MVC	Motor Vehicle Crash
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analysis
RECORD	Reporting of studies Conducted using Observational Routinely-collected health Data
RTA	Road Traffic Accident
SDG	Sustainable Development Goal
STROBE	Strengthening the Reporting of Observational Studies in Epidemiology
TBI	Traumatic Brain Injury
USD	United States Dollar
WHO	World Health Organisation

## **Part A: LITERATURE REVIEW**

### **Road traffic injuries and the burden of disease**

#### **Global Burden of Disease**

Globally, road traffic injuries are the 8<sup>th</sup> leading cause of mortality in all age groups and has now been found to be the leading cause of mortality in children and young adults within the age groups of 5-29 years. (1) It was reported by the World Health Organisation (WHO) that about 1.35 million people died as a result of road traffic injury in the year 2016 and this figure has been increasing. (1) Although the absolute mortality figures from motor vehicle crashes (MVCs) have been increasing, the mortality rate has stabilized and remained fairly constant at about 18 deaths per 100 000 population globally. (1) Progress has been reported in some areas of the world which have seen reductions in MVC-related injuries and mortality. (1) This progress has however not been equal globally, with some parts of the world experiencing increases in MVC-related injuries and mortality. (1) Despite the progress made, it has not been fast enough to meet the sustainable development goal (SDG) target 3.6 which aimed to reduce the number of road traffic deaths by half by the year 2020.

This data is contained in a report published by the WHO. The data was collected through questionnaires completed by road safety experts from the individual countries and a consensus meeting was held to validate the collected information through discussions. It is not clear what criteria was used to qualify the participants as experts. Additionally, low-middle income countries generally are known to have poor data collection systems and the statistics provided may be under reporting the status of road safety in these countries. Despite the limitations, these data may be the only statistics available for use.

#### **Burden of Disease in Africa**

The global traffic mortality rate was 18.2 deaths per 100 000 population in 2016. (1) The African and South-East Asia rate was at 26.6 and 20.7 deaths per 100 000, respectively. (1) This makes Africa the continent with the highest road traffic mortality rate in the world. The mortality rate has been found to be indirectly proportional to the income of a country. African middle-income countries had a mortality rate of 23.6 per 100 000 population while low-income African countries had a mortality rate of 29.3 deaths per 100 000 population compared to middle income countries in Europe which had a mortality rate of 14.4 deaths per 100 000 population. The increase in road traffic deaths and injuries in low- and middle-income countries (LMICs) is commonly attributed to the effects of globalisation and development which have resulted in the number of vehicles

increasing, compounded by poor road infrastructure, poor traffic laws or lack of enforcement thereof. (1)

In many parts of Africa, road traffic deaths as a result of a motor vehicle crashes remain under-reported due to absent or poor data capturing systems and the absence of such systems has a direct negative impact on healthcare planning. (2)

Despite Africa carrying the highest MVC-related mortality rate, only 39 published studies were found over a period of 35 years describing the burden of MVCs on the continent. (2) This is indicative of a lack of epidemiological studies relating to MVCs on the African continent. Without epidemiological data, informed health planning is not possible and health policies that cater to a population's needs cannot be developed.

MVC-related injury rates increased between the years 1990 and 2015 in Africa. (3) Mortality rates however decreased in the same period. (2) This has largely been attributed to advancements in prehospital care of injured patients and the emergency response systems on the continent. (2) This reduction of mortality rates associated with advancements in pre-hospital care on the continent may be an indication of the advancement in the emergency care capabilities in African countries and importantly, access to emergency care. A report by the WHO indicates that 37 African countries have emergency operations centres that co-ordinate emergency responses. It is however highlighted that these centres may not be adequately staffed and are not well integrated into the countries' emergency response systems. (4) A study conducted in 2013 and 2014 assessing the existence and distribution of emergency medical services (EMS) systems in Africa found 25 EMS systems in only 16 countries. (5) Of the findings, sub-Saharan Africa had the highest distribution of EMS systems.

Adeloye et al report a pooled fatality rate of 16.6 per 100 000 and an injury rate of 65.2 per 100 000 from the 39 studies included in the review from 15 African countries, published between 1980 and 2015. (2) Although these figures are not modelled, they only present data from 15 countries out of 52 countries on the continent. For individual user categories, Adeloye et al reports an injury rate of 10.8 per 100 000 and a fatality rate of 3.4 per 100 000 in pedestrians, a 37.2 per 100 000 injury rate and 5.9 per 100 000 amongst four-wheel vehicles and a 16.1 per 100 000 injury rate with a 1.3 per 100 000 people fatality rate in cyclists and other two wheel/three wheel vehicles in Africa. (2)

Other systematic reviews conducted found similar findings in which pedestrians are the group which makes up majority of fatalities in low- and middle-income countries compared to the four-

wheeler group which contributes greater to fatalities in high-income countries. It is further described in the studies that males, young people between the ages of 15-59 years who are the productive group of the economy are the most involved in MVCs. (6) (7) This consistent finding may be indicative of a problem that requires further investigation. Although these findings are made from African studies, epidemiological studies from Southern Africa are lacking.

This highlights limited epidemiological data of MVCs on the African continent despite a known high burden of MVCs on the continent. Our study will therefore help bridge this gap and add to the epidemiological literature of MVCs on the African continent with data captured from a reliable source.

Two studies reviewed in this section were systematic reviews and meta-analyses. Although systematic reviews and meta-analyses are ranked high on the scientific evidence ladder, the outcomes of such studies are dependent on the quality of the literature reviewed in the study. Both studies mentioned above included a large sample of studies published on the African continent, although one study had only literature from a single country which may limit generalisability to the entire continent. Both studies however employed the preferred reporting items for systematic reviews and meta-analyses (PRISMA) protocols which increases the transparency in their reporting and systemic bias was minimised through the methods used. Given the methods employed, the studies present strong evidence on the epidemiology of road traffic crashes on the African continent.

The other two studies discussed in the section were retrospective, with one prospective study. One retrospective study (Mould-Millman et al) employed questionnaires for data collection. Although a limiting method of data collection as responses are opinion based, the study results are not generalizable to many parts of Africa. It however provides important epidemiological data which can be utilised for designing prospective studies and developing new knowledge. The prospective cohort study included a large sample of patients (n=621), increasing the validity of the results. The study further utilised the STROBE guidelines for reporting observational studies thereby strengthening the transparency. Compared to the retrospective study, the prospective study was able to establish control for the quality of data collected which would improve the quality of the results and the statistical analyses conducted were relevant to the aims of the study, further strengthening the study. The recommendations made in the paper are valid as there was a large sample of patients included in the study and the design selected was valid for the objectives of the study.

## Road user vulnerability

Pedestrians and motorcycle operators are the most vulnerable groups in road traffic injuries. (1) Pedestrians injured in MVCs in Africa were reported to contribute 40% to road traffic mortalities. (8) This again is associated with infrastructure that prioritises motor vehicles. Many countries lack pedestrian and motorcycle lanes thus leaving this group prone to traffic injury and therefore mortality. (8) Similarly, pedestrian-vehicle crashes are a major concern in the United States. A 10-year (2006-2015) review of crashes involving pedestrians in the United States indicates that over the period, there were 47 789 fatalities and 674 414 injuries, the fatalities occurred mainly in the geriatric population (2.95 per 100 000) while injuries occurred in adolescents (35.23 per 100 000). (9) The odds for mortality were increased in males and crashes that occurred during the night. (9) The finding of increased mortality rates amongst the elderly may be a similar finding in the African continent as it was found that elderly patients who sustained severe TBI's were also at an increased risk of mortality compared to their younger counterparts. (10) This is most attributable to the anatomical and physiological changes that occur in geriatrics which may predispose this group to severe injury.

High-income countries have fairly well enforced laws on the use of safety items however, low- and middle-income countries do not have strict enforcement of safety wear such as helmet use with motorcycles. Despite the limited enforcement of the use of safety wear among motorcyclists, the risk of mortality in a motorcycle crash is 20 times higher in comparison to a motor vehicle crash. (8)(1) The use of motorcycles has increased in LMICs due to their affordability and this increase in relation to the odds of mortality in a motorcycle crash raises concerns in LMICs given the limited use of safety wear. (8)(1)

A Rwandan study conducted by Rosenberg et al indicates a high incidence of motorcycle crashes. (8) The injuries however recorded from these crashes are mild to moderate and this is reported to be most probably related to the road safety laws in the country relating to motorcycles. (8) Similar to the findings of Rosenberg et al, Chichom-Mefire et al in a Cameroonian study found that the majority of the patients from motorcycle crashes were discharged home from the emergency department, indicating mild to moderate injuries. (3) It is a common expectation that motorcycle crashes are associated with severe injuries due to high velocity, however due to the population density of these countries, crashes are low-speed and therefore result mainly in less severe injuries. (8) Consistent with findings in the rest of the world, economically active males are the majority of involved persons in crashes which can negatively affect their earning abilities post-crash and worsen the socio-economic status of families. (8) The findings described above are

from retrospective and prospective studies. Although limited in nature, the similar findings in the prospective study validates the results of studies and may indicate a trend for African countries. The Cameroonian study by Chichom-Mefire et al was a prospective cohort study conducted in a large centre and therefore included a large number of participants. The study findings are not far from the Rwandan study in that there is poor adherence or existence of use of safety wear among motorcyclists and injuries are associated to the lack thereof. (3) Mortality rates were higher in motorcyclists compared to the passengers in motor vehicles.

Although the specific injuries sustained are not listed in the paper by Chichom-Melfire et al, common injuries sustained from the crashes are described. Description of injuries sustained in crashes is commonly lacking from most epidemiological studies and such information is pertinent to guide healthcare planning regarding the services and specialties needed at healthcare facilities in relation to the injuries sustained.

From the literature reviewed, it is evident that pedestrians and motorcyclists are vulnerable road users and contribute significantly to the morbidity and mortality of RTAs particularly in LMICs. Mortality is increased in the older population and males who are economically active make up a significant amount of the cases.

### **Burden of Disease in Namibia**

Namibia is a sparsely populated country and the use of motorcycles for everyday transport is not as popular as mentioned in these by Rosenberg et al and Chichom-Mefire et al. Given the low population density of Namibia, the crash characteristics of motorcycles in Namibia may be different and injury trends may also be different if any findings are made in regard to motorcycles. In the year 2022, 73 motorcycles were involved in crashes and resulting in 48 injured cases and 3 fatalities. (11) This represents a 1.7% of the total crashes that occurred during the year 2022 thus supporting the claim of the unpopular use of motorcycles in the country. (11) The severity of injuries sustained from motorcycles crashes is however not described and the current study could describe these characteristics and compare to countries with higher population densities.

Namibia, according to the WHO in the year 2018 had the highest MVCs related fatality rate in the world. (12) It is however acknowledged that, research on MVCs remains limited in the country. Chatakuta in the year 2021 analysed the risk of mortality or injury following an MVC in Namibia and found that motorcyclists were at a higher risk of mortality and injury followed by pedestrians. (12) The study was a retrospective review of published reports from a road safety agency.

Literature from Namibia on the subject are however lacking. The study findings are however in line with other African countries and the world at large.

Namibia in the year 2022 recorded a total number of 3 072 crashes which resulted in 5 733 injured persons and 466 fatalities. (11) According to the MVA Fund Crash Report for the year 2022, the country had a vehicle population of 403 839 and a population of 2 596 037 persons. (11) The mortality rate for the year was 18 per 100 000 persons and an injury rate of 202.9 per 100 000 persons. (11) Compared to the 3 preceding years, some of these rates have seen a gradual decrease. It is worth noting that the year 2020 and 2021, the COVID-19 pandemic might have contributed to these figures as the crash numbers decreased during this period with a slight increase in 2022. (11) During 2022, December had the highest number of people injured in MVCs and that trend has been the same for the preceding 4 years. December falls within the Nambian holiday season and MVCs normally increase during this festive season.

Due to the expected increase in MVCs over this festive period, road safety stakeholders conduct safety campaigns to curb the increase. The latest festive season road safety campaign report available online from the MVA Fund indicates that for the 2015/16 season, there were 589 crashes, 1 233 injuries and 112 fatalities over the period. (13) This is a period of about 2 months only, spanning from 22 November 2015 to 15 January 2016. The data above indicates the seriousness of MVCs in Namibia.

### **Ambulance distribution in Africa**

Ambulances are part of emergency care systems and emergency medical service systems. Emergency medical service systems are defined as prehospital medical care of medical emergencies delivered by qualified professionals in a well-defined jurisdiction. (5) Reductions in MVC-related fatalities have been attributed to advancements in EMS systems in some parts of Africa. (3) These findings were made in a prospective cohort study conducted in Cameroon, a Sub-Saharan country which aimed to describe crash characteristics and the epidemiology of motorcycle crash related injuries. (3) Despite this, little is however known about the state of EMS on the African continent due to lack of research on the topic.

Access to emergency care is important as morbidity and mortality can be significantly reduced. (14) It is estimated that up to 45% of trauma mortalities and 35% morbidity can be generally reduced through the establishment and provision of adequate pre-hospital emergency care and systems. (14)

A study conducted to determine the time taken to reach a healthcare facility in Ethiopia following a traumatic insult shows that it was faster for patients transported by taxis to reach a healthcare facility in comparison to those that travelled with ambulances. (14) A total of 28 (16.5%) patients reached hospital within 60 minutes when transported by ambulance, while 57 (33.5%) reached the healthcare facility by taxi.(13) This finding may be related to the accessibility of EMS.

This was a cross-sectional study conducted in Ethiopia and results cannot be generalised to the entire population. The results do however highlight a barrier to accessing emergency care which may require further investigation. African studies describing the state of EMS generally report inequalities in accessing these services. (5) (15) (16) The studies further highlight inadequacies in all the 6 EMS pillars evaluated namely: leadership and governance, finance, information, workforce, medical products and service delivery at both national and sub-national levels. (16) The authors infer that the study results can be extrapolated to most LMICs in Africa without well-developed EMS systems. Little is known about the ambulance distribution and capacities of the EMS system in Namibia despite being a middle-income country in which the burden of MVC-related injuries is of significance.

Relating to Namibia, establishing hotspots (crashes/fatalities) can inform the relevant authorities on the services that may be required in an identified area. Access to geo-spatial data also allows for serial measurements to be conducted to determine improvements in patient outcomes in accordance with interventions implemented. The current study aims to determine any hotspots across the country regarding crash characteristics which may inform future healthcare planning.

### **Geospatial analysis of crashes**

Sundet et al geographically mapped the location of injuries sustained from MVCs in Malawi. (17) The study, retrospective in nature found hotspots in Rwanda where along the highways and at busy road intersections. The data were collected in-hospital, in the emergency department in relation to other studies who commonly use police records for geospatial mapping of MVCs which the authors argue that the presence of police may introduce response bias into the study results and question the completeness of police records particularly in developing countries who have under-developed data capturing systems. (17) The study was limited however, the absence of epidemiological data in Sub-Saharan countries are the only source of data hence the importance to conduct epidemiological studies in order to increase the available African literature which this current study aims to achieve. The current study will utilise pre-hospital data for geo-spatial analysis.

Hotspot analysis and identification can be used to guide healthcare planning and deploying of resources such as ambulances and human resources. (17) Additionally, identifying these MVC hotspots may identify areas of concern and therefore direct preventative interventions.

### **Cost of MVCs in Africa**

MVC injuries are associated with a significant financial burden to countries due to the high cost involved in the medical management of MVC injured patients. The annual financial cost of MVC related injuries was reported to be over USD \$518 billion globally and between USD \$65-100 billion in LMICs. (8) (18) This was based on data published in the year 2000 and 2020 respectively. MVC related injuries are classified as non-intentional injuries and carries the highest cost.

Although majority of the cost associated with unintentional injuries is secondary to MVC related injuries, data from LMICs remains lacking as few studies exploring the costs of MVC related injuries have been done, with the most available data from HICs. (12) Most economic cost data of MVCs is therefore estimated and these figures may not always be accurate.

Globally, countries are said to lose between 1-3% of their gross domestic product (GDP) to MVC related injuries. (19) It is estimated that the economic impact is worse for Sub-Saharan countries whose economies are mainly developing. (19)

A 2011 Kenyan study by Bachani et al reported that in the year 2011, MVC related injuries were estimated to have resulted in a financial cost of USD \$3.8 billion annually since the year 1991 and this was equal to 5% of the gross national product (GNP). (20) In the year 2012, MVC related injuries accounted for USD \$10.5 billion in healthcare expenses in South Africa, equivalent to about 3% of the country's GDP. (21) In the year 2015, the total cost of MVC was estimated to be over R 142 billion, equating to 3.4% of South Africa's GDP. (22) This is an increase of 0.4% in 3 years which is indicative of a worsening burden on the country's economy. No literature describing the cost of MVCs per capita and in relation to the country's GDP from Namibia was found however an epidemiological study exists describing the cost of managing TBIs. The study, a retrospective observational review of adult patients with severe traumatic brain injury (TBI) secondary to MVCs in two Namibian regions, the associated medical cost of managing 87 patients was USD \$1 865 251.34 over a 5-year period. (10) This study provided an indication of the financial burden that MVCs carry in LMICs. The study was however limited as it presented only the medical costs of patients who sustained severe TBIs in 2 Namibian regions secondary to MVCs over the stipulated period. It is worth mentioning that the costs are only those related to the medical management of

patients and the full economic costs are not described in the study discussed, further raising the concern of the economic cost and burden of MVCs in Namibia and other LMICs in Africa. An epidemiological study of MVCs in the entire country could provide a more accurate representation of the burden of MVCs in Namibia.

A 2020 published epidemiological study of motorcycle crashes in Rwanda by Rosenberg et al estimates an annual economic cost of MVCs to be between USD \$65-100 billion. (8) Rwanda is expected to spend USD \$347 million between the year 2015 and 2030 on MVCs which will result in a per capita loss of USD \$25. (8) Again, the figures presented above are estimates and are not actual. Apart from the direct cost burden of the MVCs on the country, there are ripple effects that compound the burden of disease due to the socio-economic impact of the MVCs. Most people are injured in MVCs are economically active and make-up the labour force of these countries with resultant loss of the labour force and livelihoods.

It has been found that an increase in the MVC related injuries is associated with a resultant reduction in the GDP of a country and an increase in the GDP has a resultant increase in the MVC fatality rate in LMICs. (23) Most of the data found is however over a decade old and there has been a call by the WHO for more recent data particularly on the African continent and in LMICs. (21) From the cost described here, it is evident that there is a significant financial burden associated with MVC related injuries. The data is aged and with increases in medical care over the years, it is expected that the cost to date is significantly higher than described by these publications.

## **Conclusion**

MVCs remain a leading cause of morbidity and mortality in the world. Africa however carries the highest fatality rates compared to other continents. The United Nation SDG's aims to decrease the MVC related injuries and fatality rates however despite the efforts the reductions in MVCs related injuries have not been equitable across the world.

In the HIC, epidemiological studies exist which can be used to guide healthcare planning and aid in the reduction of morbidity and mortality related to MVCs. A common challenge faced on the African continent however is the lack of epidemiological data to inform healthcare planning, research on the matter remains lacking in the country and the study aims to narrow these knowledge gaps that have been identified.

From the literature reviewed it is evident that epidemiological studies specific to MVCs are limited in Namibia. These studies are essential for healthcare planning. Furthermore, no economic data was found related to MVCs in Namibia. The current study aims to describe the epidemiology of MVCs and associated patient demographics, describe the geospatial nature of MVCs and the healthcare costs of MVCs in Namibia which will narrow the knowledge gaps that exist and develop data that can be utilised for healthcare planning.

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## **Part B: MANUSCRIPT**

A Retrospective Review of Motor Vehicle Crashes during the 2022 December Festive Season in Namibia

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## Abstract

**Introduction:** Motor vehicle crashes (MVCs) are a public health concern and a major contributor to the morbidity and mortality of trauma patients globally. Morbidity and mortality from MVCs are forecasted to increase significantly by the year 2030. In 1998, MVCs were ranked as the 9<sup>th</sup> leading cause of global disease burden however this has risen to 3<sup>rd</sup> in 2020. Namibia is a Sub-Saharan country with a high number of MVCs however with limited epidemiological data. The study therefore aimed to describe the epidemiological characteristics of motor vehicle crashes in Namibia over a 1-month period during the 2022 festive season period.

**Methods:** A descriptive observational study in the form of a retrospective review was conducted to describe the epidemiological characteristics of motor vehicle crashes in Namibia over 1 month period during the 2022 festive season period. The data was collected from the MVA Fund, a state-owned organisation, and analysed. The data was subjected to chi-square tests to determine association between variables and a geospatial analysis was done for the location data. Data was geocoded using the ESRI World Geocoder in ArcGIS Online. The data was subjected to cluster analysis and hotspot analysis.

**Results:** A total of 292 crashes were included in the study with Khomas region recording the most (n=60). The majority of the crashes recorded, occurred in the evenings (18h01-21h00). No statistically significant differences were observed between the day of the week crashes occurred and the region in which they occurred (p-value=0.595). A statistically significant difference was however observed in the time of day the crashes occurred and the region (p-value= 0.046). A total of 87 patients were included from the 292 crashes. Of the 87 patients, 24 were female (27.6%) and 63 patients were male (72.4%). There were three fatalities. Females in the age group of 51-55 years were the most injured while males between 31-35 years were most injured. Fractures were the most common injury sustained. The total medical cost associated with management of these patients was over N\$ 15 million over the study period.

**Conclusion:** Young males are the majority of people involved in MVCs as found by our study and in line with global findings. The majority of individuals injured in crashes are within working ages and would be involved in the economic activities of the country. Injuries to these groups may have far-reaching socio-economic consequences. Lastly, MVCs over a month period alone carried a high cost and the annual cost of the medical management would be significant which may further negatively impact the country's economy. To curb the burden of crashes, interventions targeted specifically to the most affected population are required. Furthermore, the state of EMS in the crash clusters needs to be evaluated to identify any gaps. Identification of

gaps could be used to strengthen EMS in these clusters and therefore lessen the trauma and mortality burden of crashes. It is well established in the literature that effective emergency care can alleviate most trauma morbidity and mortality.

## Introduction

Motor vehicle crashes (MVCs) have been described as a public health concern and contribute significantly to the morbidity and mortality of trauma patients globally.(1) In a study published in the year 2004, it was estimated that over 1.2 million people were killed in motor vehicle crashes in the world while over 1 million people were injured or left disabled.(2) This translated to 3.6 percent of the global mortality burden as a result of MVCs.(3) In the year 2004, MVCs were estimated to have accounted for 2.7 percent of the total disability-adjusted life years (DALY) worldwide, a figure that is forecast to increase to 4.9 percent by the year 2030 and therefore places MVC related injuries as the third leading cause of the global disease burden.(3) In 1998, MVC related injuries were ranked as the 9<sup>th</sup> leading cause of the global disease burden and in 2020, this ranking has increased to the 3<sup>rd</sup> position.(4) This indicates a trend towards the predicted ranking in 2030.

In high-income countries (HICs), the burden of MVCs has been decreasing, and this has been attributed to various factors such as enhancements in pre-hospital care and emergency medicine to name a few.(5) The disease burden in low- and middle-income countries (LMICs) is however increasing. This increase is associated with the development of road systems in LMICs, and an increase in motor vehicles which has subsequently increased MVCs and related injuries.(3) LMICs are said to carry approximately 90 percent of the MVC-related injuries' disease burden with about 205 000 fatalities and 7 151 000 DALYs lost secondary to MVCs.(3) This translates to 969 DALYs per 100 000 in Africa while the global DALY rate is at 640 DALYs per 100 000 population. This indicates the magnitude of the disease burden in Africa.

Namibia, a Sub-Saharan country located on the southern end of Africa has a high number of MVCs. In the year 2016, the World Health Organization (WHO) estimated the MVC related mortality rate of Namibia to be 30.6 per 100 000 population.(6) Like many other African countries, Namibia's healthcare sector is low-resourced and burdened by a high number of MVCs. This is despite Namibia being one of the upper-middle-income countries with the highest government expenditure on healthcare however, healthcare personnel are inadequate to meet the system needs and health outcomes remain low. (1) (2)There is however limited published data describing the burden of MVCs in the country.

Additionally, Namibia is a vast country and distances between towns are large. Given the high MVC rate, placement of emergency services is of utmost importance. To date, there is no known published study describing the distribution of ambulances nor a geospatial analysis of MVCs in Namibia that can potentially inform health resources allocation. The study therefore aimed to

describe the epidemiological characteristics of motor vehicle crashes in Namibia over a 1-month period during the 2022 festive season period.

## **Methodology**

### **Study design**

A descriptive observational study in the form of a retrospective review was conducted to describe the epidemiological characteristics of motor vehicle crashes in Namibia over a 1-month period during the 2022 festive season period. The study received ethical approval from the Human Research Ethics Committees of the University of Cape Town (HREC Ref: 669/2023) and the Ministry of Health and Social Services of Namibia (Ref: 22/4/2/3). In addition, written permission to conduct research was granted by the MVA Fund. To respect patient confidentiality and anonymity, no patient identifiable data was extracted. This study is reported in accordance with the REporting of studies Conducted using Observational Routinely collected health Data (RECORD) an extension of Strengthening the Reporting of Observational studies in Epidemiology (STROBE). (3)

### **Setting and population**

The study was conducted in Namibia in MVCs that resulted in injury to the persons involved. Namibia is a southern African country bordering the Republic of South Africa in the south, Botswana in the east and Angola in the north. (4)

The country had an estimated population of 3 022 401 people according to the 2023 National Census and is divided into 14 regions. (5) (12) Between the years 2015 and 2019, 19 814 crashes with injuries were recorded, (12, 13, 14, 15) while 8 992 crashes with injuries were recorded between the years 2020 and 2022. (16)

The MVA Fund is a state-owned organisation in Namibia founded by an act of parliament, MVA Fund Act, no.7 of 2007 which is mandated among others to aid persons injured in MVCs, through insurance (14) As part of the mandate, the MVA Fund operates a 24-hour National Emergency Communications Centre (ECC) through which emergency services (police, emergency medical rescue services) are dispatched, co-ordinated and through which data is primarily collected.

The study population was all MVCs recorded by the MVA Fund over a 1-month period during the December 2022 festive season. However, only patients who sustained significant injuries warranting hospital admission were included in the accessed data and analysis. MVCs in the

study context are all crashes involving motorised vehicles inclusive of pedestrian-vehicle crashes where persons are injured.

## **Data Collection**

Data was collected from the MVA Fund database by the principal investigator. The MVA Fund, primarily through the ECC only records crashes which result in injuries and fatalities. (17) The recorded data is verified with the Namibian police service, ambulance service providers who respond to the scene of the crash, and with medical facilities to which the patients are transported to for further management. (17) To ensure data accuracy, the MVA Fund's business unit responsible for data draws weekly reports to assess for missing data points in the recorded crashes. Any incomplete crashes are sent to the ECC to follow up with the stakeholders and complete the missing data points.

The MVA Fund system was used to determine crash characteristics (location, time of day) and patient data (sex, age, injuries, medical costs). Injuries referred to the physical harm that a patient sustained because of the MVC and health facility was a physical location at which healthcare services were provided to the patient. The injuries were extracted from the MVA Fund database as recorded on the system (ICD-10 codes and manual injury entries). Only patients with significant injuries who were admitted to a hospital were recorded on the accessed data. These patients had complete details including ICD-10 codes which would enable analysis of the data to achieve the study objectives. The data collected was organised and cleaned in a 2013 Microsoft Excel spreadsheet (Microsoft Corporation, Washington, United States). (18)

Key variables were defined in a data dictionary to ensure that a consistent understanding was maintained amongst all involved in the project. (*Appendix 1*) A standard excel (Microsoft Corporation, Washington, United States) spreadsheet was designed and used for capturing the research data and regular meetings were held with the research team throughout the data collection period to ensure that the research was conducted according to the approved protocol and ensure early detection of deviations.

## **Data Analysis**

The cleaned data was imported to the SPSS statistical package, Version 27 (IBM Corp., Armonk, New York, United States) for statistical analysis. For descriptive statistics, measures of frequency (count, proportion and percentages) and measures of central tendency (mean, median, mode) were calculated as appropriate for the type of data (categorical or numerical) and presented in

tables and graphs. Frequency data was expressed as incidences. Pearson chi-square tests were done to determine the association between variables.

For the temporal analysis, distribution of MVCs according to time of day, day of the week and month of the year were subjected to chi-squared testing. A significance level of 95% ( $p < 0.05$ ) was set.

The geospatial analysis was performed using the location data variables. Location data were geocoded using the ESRI World Geocoder in ArcGIS Online (Esri, California, United States). All other geospatial analyses were performed using ArcGIS Pro 2.6.3 (Esri, California, United States). The data were subjected to cluster analysis, and hotspot analysis using the ArcGIS spatial statistics tools. Clustering was based on regions of spatial aggregation of crashes, with 50 or more aggregates considered a cluster. No data transformation was applied. For hotspot analysis, Getis-Ord  $G_i^*$  was applied to data aggregated by hexagonal tessellation (10km<sup>2</sup>/hexagon). Hot and cold spots were detected along a 90%, 95% and 99% confidence. Lastly, outlier analysis for fatalities was planned using Anselin Moran's  $I$ , but this was abandoned because death was a rare outcome, lacking sufficient power to run the analysis.

## Results

### Crash characteristics

During the month of December 2022, a total number of 292 crashes were recorded. Khomas region had the highest number of crashes (n=60) followed by Erongo region (n=44) and the Oshikoto and Otjozondjupa regions both recorded 34, respectively. Table one below shows the number of crashes per region.

Table 1. Number of crashes per region

<b>Region</b>	<b>Number of Crashes n (%)</b>
Khomas	60 (20.5%)
Erongo	44 (15%)
Otjozondjupa	34 (11.6%)
Oshikoto	34 (11.6%)
Oshana	29 (9.9%)
Kavango East	14 (4.8%)
Ohangwena	14 (4.8%)
Omusati	13 (4.5%)
Zambezi	12 (4.1%)
//Karas	10 (3.4%)
Hardap	9 (3%)
Omaheke	9 (3%)
Kunene	5 (1.7%)
Kavango West	5 (1.7%)
<b>Total</b>	<b>292</b>

The highest proportion of crashes occurred on a Saturday (n=58) followed by Friday (n=54). Table 2 below shows the crash distribution by the day of week. The lowest number of crashes were

recorded on Mondays (n=24). The highest proportion of crashes in the Erongo region were recorded on Saturday (n=11) and Sundays (n=10) while the Khomas region's highest crash numbers were recorded over the weekends (Friday to Sunday).

Table 2. Crash distribution by day of week

REGION	DAY OF WEEK OCCURRED		Total (n=292)
	Weekday (Mon-Thur) P-value= 0.673	Weekend (Fri-Sun) p-value= 0.673	
//Karas	5 (1.7%)	5 (1.7%)	10 (3.4%)
Erongo	19 (6.5%)	25 (8.6%)	44 (15.1%)
Hardap	4 (1.4%)	4 (1.4%)	8 (2.7%)
Kavango East	7 (2.4%)	7 (2.4%)	14 (4.8%)
Kavango West	5 (1.7%)	0 (0.0%)	5 (1.7%)
Khomas	23 (7.9%)	38 (13%)	61 (20.9%)
Kunene	3 (1%)	2 (0.7%)	5 (1.7%)
Ohangwena	8 (2.7%)	6 (2.1%)	14 (4.8%)
Omaheke	5 (1.4%)	4 (1.4%)	9 (3.1%)
Omusati	6 (2.1%)	7 (2.4%)	13 (4.5%)
Oshana	13 (4.5%)	16 (5.5%)	29 (9.9%)
Oshikoto	13 (4.5%)	21 (7.2%)	34 (11.6%)
Otjozondjupa	16 (5.5%)	18 (6.2%)	34 (11.6%)
Zambezi	6 (2.1%)	6 (2.1%)	12 (4.1%)
Total	132 (45.5%)	160 (54.5%)	292

No statistically significant difference was found in the occurrence of crashes between the region and the day of the week (p-value= 0.673).

Forty-two percent (42%, n=122) of crashes occurred during the late afternoons and evenings (15h01-21h00), reaching a peak between 18h01 and 21h00 hours, with this time interval registering 67 (23%) crashes.

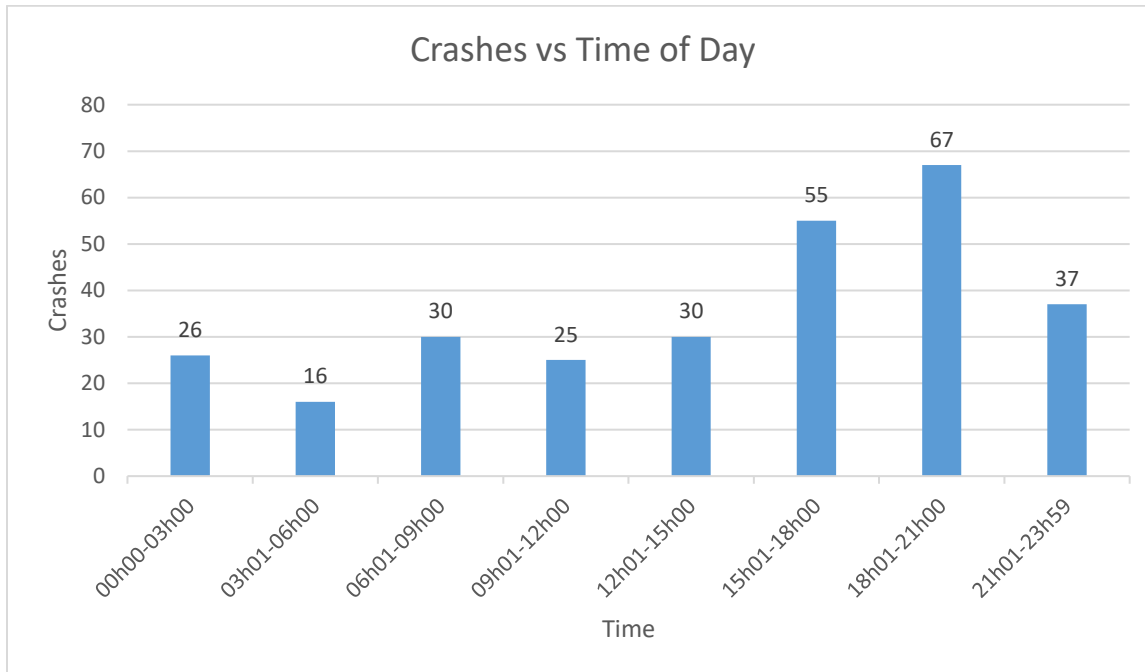


Figure 1. Crash vs time of day

There was no statistically significant difference in the time of day the crash occurred ( $p$ -value= $<0.463$ ), there was however a statistically significant difference in the time the crashes occurred and the region ( $p$ -value=0.046). Between 18h01-21h00, the Khomas region recorded the highest crashes ( $n=16$ ) followed by Erongo region with 10 crashes and the Otjozondjupa region with 10 crashes. Similarly, between 15h01-18h00, the Erongo region recorded the highest number of crashes ( $n=12$ ) followed by Khomas with 11 crashes. Otjozondjupa, Oshana and the Omusati region each recorded 5 crashes respectively. There was further no statistically significant difference in the day of the week the crash occurred and the region ( $p$ -value= 0.595).

Most of the crashes recorded occurred on a Saturday ( $n=57$ ), Friday ( $n=54$ ) and Sunday ( $n=48$ ). These days are classified as weekend in the study. Figure 2 shows the crash peak days.

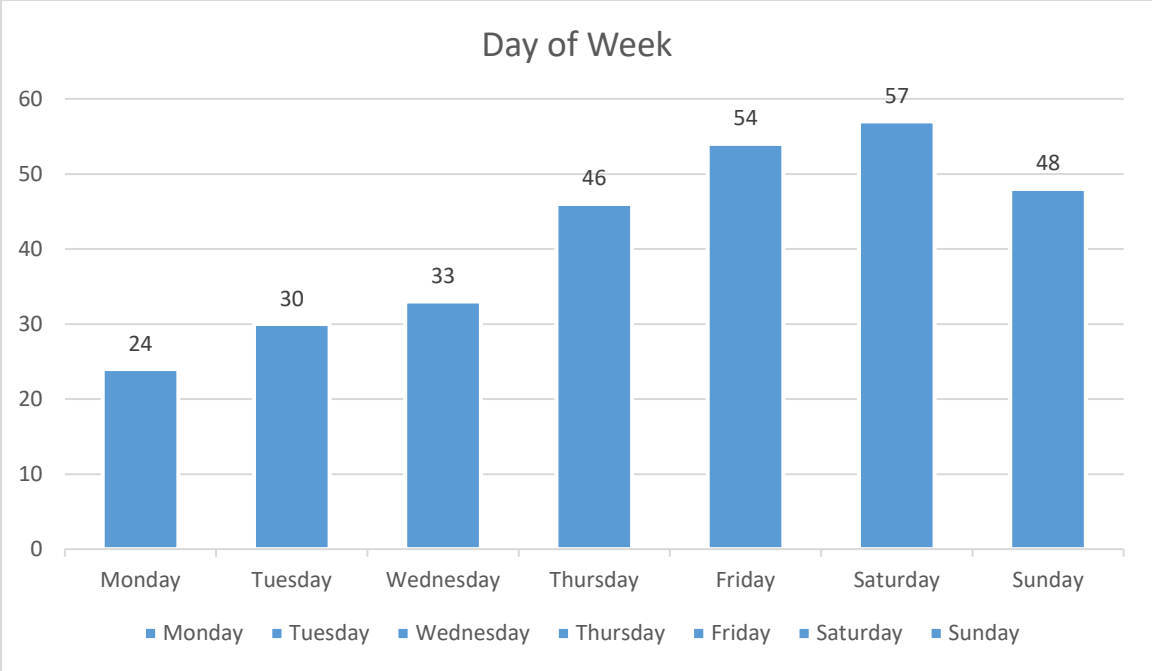


Figure 2. Crash peak days

**Patient Characteristics**

Eighty-seven (87) injured cases were recorded during the period (December 2022). These are only patients who sustained a significant injury that warranted hospital admission. The distribution of patients by sex shows that 24 (27.6%) of the cases were female while 63 (72.4%) cases were male. Out of the 87 cases, 3 died and 84 persons were injured.

Table 3. Distribution of sex and casualty status

Characteristics	Count n=87
<b>Gender:</b>	
Female	24 (27.6%)
Male	63 (72.4%)
<b>Casualty Status:</b>	
Deceased	3 (3.4%)
Injured	84 (96.6%)

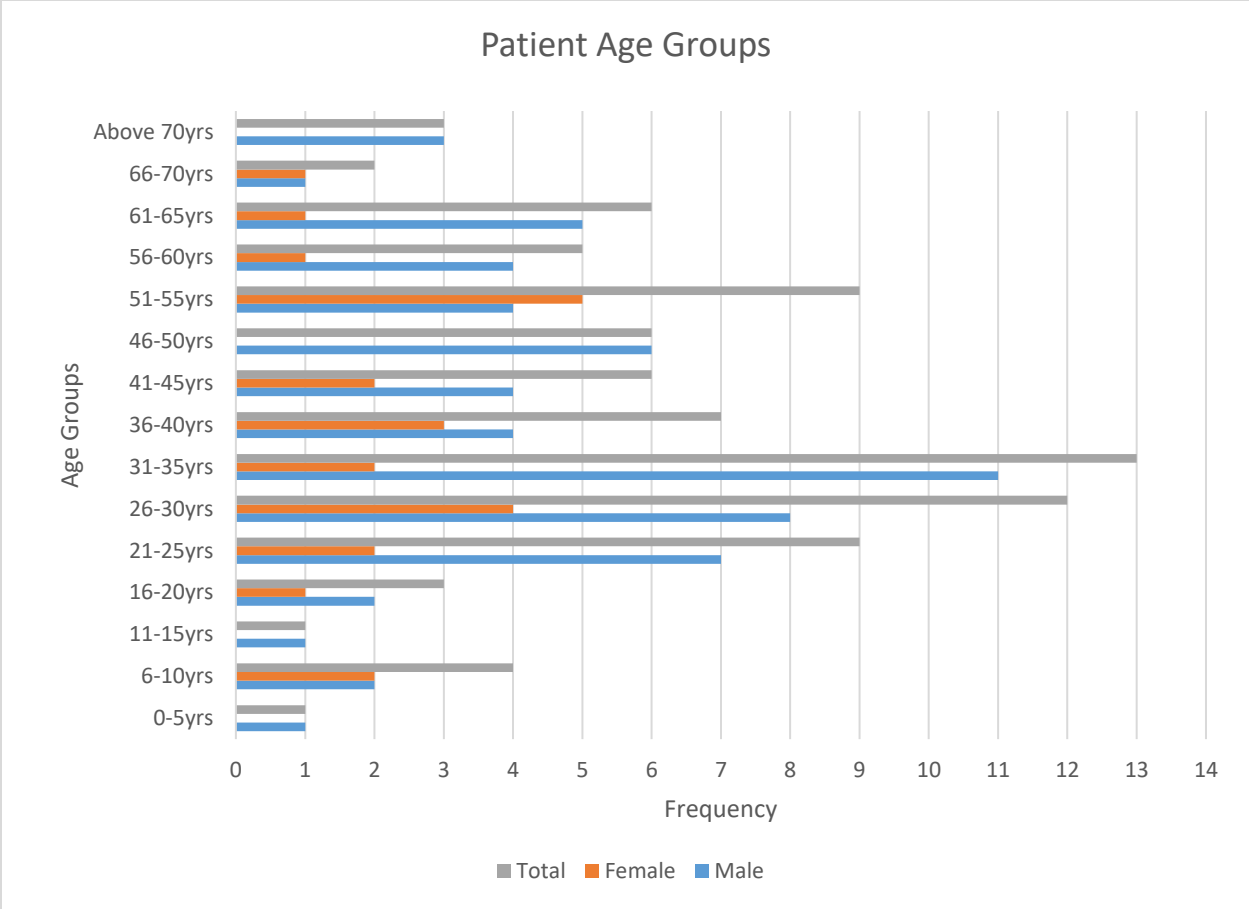


Figure 3. Patient age groups

Sixty-three (72.4%) of the individuals who sustained injuries during the festive season of December 2022 were male, with higher proportions observed among passengers and pedestrians. Among these, male passengers constituted 31% of the total of the injured, while male pedestrians accounted for 19.5%. In contrast, female passengers and pedestrians made up 18% and 6.9% of the total number of injured cases, respectively. No statistically significant difference was found between the age groups and gender (p-value=0.607).

Table 4. Patient person class

Person Class	Female (n=24)	Male (n=63)	Count (n=87)
Cyclist	0	1 (1.6%)	1 (1.1%)
Driver	2 (8.3%)	17 (27%)	19 (21.8%)
Other	0	1 (1.6%)	1 (1.1%)
Passenger	16 (66.6%)	27 (42.9%)	43 (49.4%)
Pedestrian	6 (25%)	17 (27%)	23 (26.4%)
<b>Total</b>	<b>24 (27.6%)</b>	<b>63 (72.4%)</b>	<b>87 (100%)</b>

The Oshikoto region recorded the highest total number of cases during the period studied (n=18) followed by the Khomas and Oshana regions with each recording 16 cases and Otjozondjupa with 9 cases. The most injured person class were passengers (n=43), pedestrians (n=23) and thirdly drivers (n=19). The Oshikoto region recorded the highest number of injured passengers (n=9) while Khomas had the highest injured pedestrians (n=7) and drivers were most injured in the Oshikoto region. Figure 4 presents the cases per region.

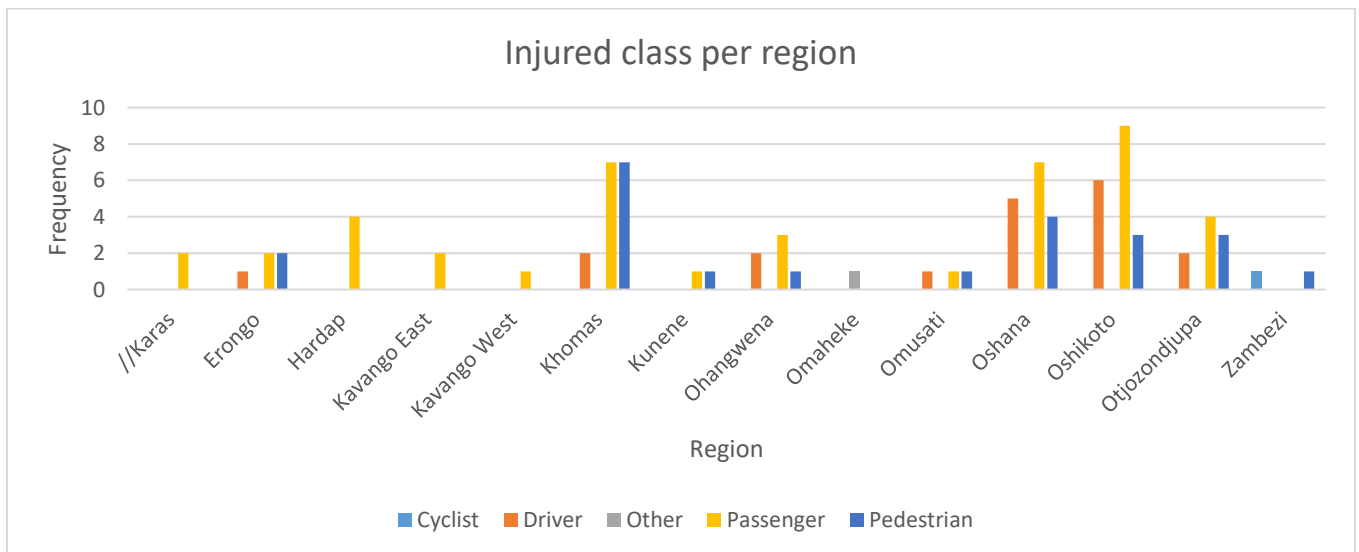


Figure 4. Injury class per region

No statistically significant difference exists between the cases in the region and the person class (p-value: 0.944).

## Injuries

The majority of the patients sustained multiple injuries (n=45, 51.7%) followed by fractures (n=22, 25.3%). Multiple injuries were described as 2 or more injuries of different anatomical regions (e.g. fracture and traumatic amputation). Of the patients who sustained multiple injuries, traumatic pneumothoraces (n=6), tibial shaft and fibula fractures (n=6), humerus shaft fractures (n=6), burst fractures of unspecified thoracic vertebra (n=4), and upper end tibial fracture (n=3) were the most common. Table 5 below presents the injuries.

Table 5. Injuries sustained

<b>Injury</b>	<b>Count (%)</b>
Abdominal Injury	1 (1.1)
Brain Injury	4 (4.6)
Chest Injury	2 (2.3)
Fractures	22 (25.3)
Multiple Injuries	45 (51.7)
Other	4 (4.6)
Soft Tissue Injury	1 (1.1)
Spinal Fracture	1 (1.1)
Unspecified	7 (8)
<b>Total</b>	<b>87</b>

## Medical Costs

The total medical cost associated with the management of the 87 cases included in the study was N\$ 15,532,068.91 over a 1-month period (December 2022). Oshana recorded the highest expenditure of N\$ 3,475,825.51 for 16 cases followed by Khomas (N\$2,422,267.07) and Oshikoto (N\$2,138,771.23). The medical cost of the regions are presented in table 6 below.

Table 6. Medical cost per region

<b>Region</b>	<b>Number of Cases (n=87)</b>	<b>Cost (N\$)</b>	<b>Average Cost per Case (N\$)</b>
//Karas	2	122,744.18	61 372.09
Erongo	5	1,155,681.23	231 196.25
Hardap	4	1,305,252.62	326 313.16
Kavango East	2	887,800.44	443,900.22
Kavango West	1	169,524.26	
Khomas	16	2,422,267.07	151 391.69
Kunene	2	484,710.80	242 355.40
Ohangwena	6	1,206,339.73	201,056.62
Omaheke	1	73,523.78	
Omusati	3	237,957.04	79 319.01
Oshana	16	3,475,825.51	217 239.09
Oshikoto	18	2,138,771.23	118 820.62
Otjozondjupa	9	1,626,450.55	180 716.73
Zambezi	2	225,220.47	112 610.24
<b>Grand Total</b>	<b>87</b>	<b>15,532,068.91</b>	<b>2 567 376.60</b>

## Geospatial Analysis of Crashes

The 292 crashes that occurred during the December 2022 period are presented below according to the location in the country (Figure 5). The crash clusters are presented in figure 6.

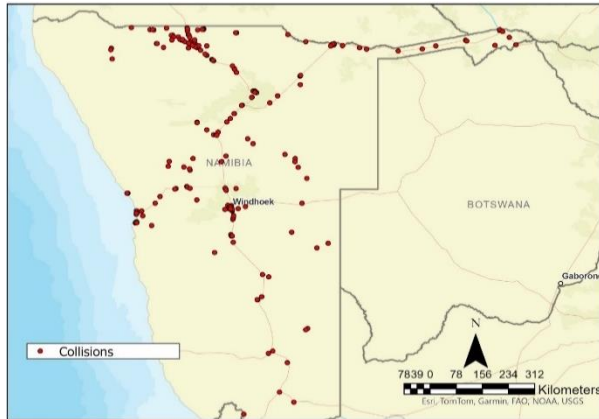


Figure 5. December 2022 crashes in Namibia

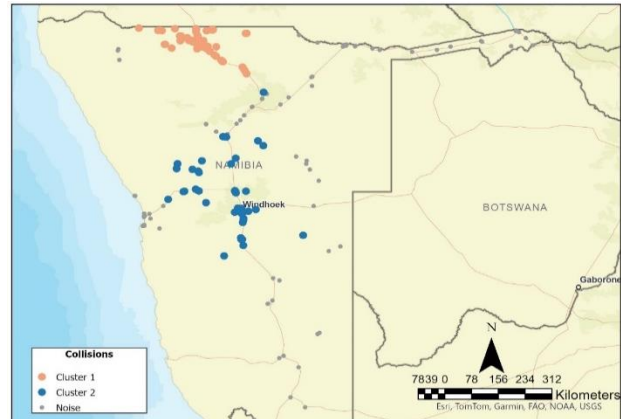


Figure 6. Crash clusters in the country

The map below shows the significant crashes hotspots (figure 7) in the country. Significant crash hotspots were those with a 95% confidence. The majority of the crash hotspots are located within the Khomas region.

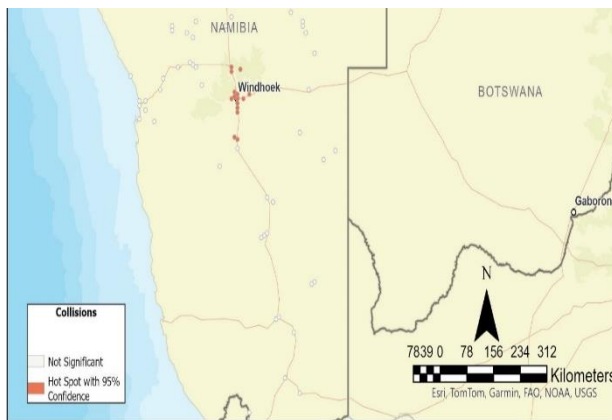


Figure 7. Significant crashes in the country

## **Discussion**

The study aimed to describe the epidemiological characteristics of crashes over a month period during the 2022 December festive season in Namibia.

### **Timing of crashes**

Our study found that the highest proportion of crashes occurred over the weekends (Friday-Sunday) and crashes peaked during the late afternoons and evenings. The high occurrence of crashes over the weekends is consistent with findings from other studies conducted in Nigeria, Ethiopia and Uganda (6) In our study, we found that crashes peaked during the late afternoons and evenings however most African studies suggest that a high proportion of crashes occurred during daylight. (7) A study from Ethiopia however made a similar finding in which most crashes occurred during the evenings. The study did not explore reasons for this finding however association could be made to alcohol consumption at night and low visibility which could increase the risk of a crash.(8) Anecdotally, weekends in Namibia are associated with an increase in alcohol consumption, travel and other social activities with resultant reckless and negligent driving which could increase the risk of MVCs, these are all recognised risk factors that increase the chances on MVCs. (9) Additionally, the study was conducted during a festive season in Namibia which is associated with increased travel and a higher occurrence of crashes which may have influenced the observed trends which in normal circumstances may have been different. Specific studies such as those exploring the incidence of alcohol intoxication in drivers involved in crashes, and the correlation of long-distance driving and occurrence of a crash are required to explain the high proportion of crashes over the weekends.

### **Patient Characteristics**

Over 70% of the patients who sustained injury during the study period were males and most were aged between the ages of 31-35 years. Globally, it is well established that males remain the most involved gender in motor vehicle crashes. (9) This finding in many studies has been associated with risky behaviour of men which increases the chances of an MVC. (9) (10) (11) Some of the identified risks are alcohol consumption, reckless driving and contravening speed limits. (9) (10) (11) The ages involved are those of economically active persons and this is well established globally with serious socioeconomic impacts on affected countries. (12) This is no coincidence as these are the people who are mainly road users daily.

Pedestrians ranked second in our study as the most injured person class. This remains a vulnerable class of road users particularly in LMICs, contributing greatly to morbidity and mortality

of MVCs. (9) Road infrastructure that prioritises vehicles has been attributed to the high involvement of pedestrians in motor vehicle-related crashes which may warrant a change in the design of road infrastructure especially in urban areas to curb the issue. (12) The study identifies the most affected group, male adults and this finding is in line with findings made in several other studies. (9) (10) (11) Many road safety interventions are conducted to reduce the number of crashes in the country. Strategies should be crafted targeting particularly young males who are the majority of the persons involved in crashes. Interestingly, as discussed earlier, males in the age group 31-35 years were the most injured in the study however, females between the ages of 51-55 years were the most injured in the study. This finding is not explained herein however it warrants further investigation as it is well established and explained on the association of the male age group in crashes however no reference is made to the female ages.

### **Injury Patterns**

The majority of patients sustained fractures as a result of the crashes. This finding is similar to studies from other African countries and elsewhere. (13) (14) This finding is not surprising given the nature of crashes and the mechanical forces involved in collisions. Associations have not been made to the injuries however the finding is important in planning healthcare services given the high occurrence of fractures in MVCs. The data can be used in the purchasing of equipment and human resource planning to meet the needs of patients.

### **Geospatial Analysis**

The study was one of the few that analysed the spatial nature of crashes in the country. Most crashes were clustered in the northern part of the country along the main national roads with most significant crashes occurring in the Khomas region. The 4 northern regions of Namibia (Oshikoto, Ohangwena, Oshana, Omusati) have a combined population of 1 142 503 people according to the 2023 Namibian population and housing census. (5) Thirty-seven (37) percent of the Namibian population therefore live in these 4 regions making it some of the densely populated areas of the country. The B1 road however runs from the south of the country in Karasburg to Ondangwa is one of the main roads into these regions and the road traffic is further increased during this holiday period which could be associated to the cluster observed in the northern region. Other studies conducted in Malawi and Tanzania describing geospatial location of crashes have also analysed the severity of injuries sustained at the hotspots. (15) (6) Our study identified only hotspots at which a high number of crashes occurred. The importance of the analysis in our study however is the potential to guide deployment of ambulances, traffic law units during periods of expected

high traffic volumes and possibly identify areas of requiring engineering interventions to reduce the number of crashes. This however requires further investigation.

### **Medical Costs**

The study reviewed cases only over a month period during December 2022. A total of N\$ 15,532,068.91 was spent on the medical treatment of 87 patients with an average of over N\$ 178 529.53 per patient. The figure represents only a cost for the medical treatment of patients injured during December 2022 month which was the study period. The Namibian government in the 2022/23 tabled a N\$ 8.4 billion budget for the Ministry of Health and Social Services (MoHSS). (1) This was the year in which the study was conducted and the medical cost over the 1-month period would have been 0.18% of the national budget of the MoHSS. Although this figure presented herein was not spent from the national budget of the MOHSS, this percentage of the budget spent on the medical management of patients who sustained injury in MVCs over a month period provides an indication of the burden of disease associated with MVCs. A review of crashes in the entire country would indicate accurately the financial burden associated with crashes. However, it is evident from the results that crashes have a significant burden of disease as described by the WHO.

### **Study Limitations**

The study had several limitations. The study was a retrospective review of recorded data. The quality of the data could however not be controlled in the study. The study further collected data from one source only, the MVA Fund of Namibia. The MVA Fund only records crashes in which injury occurs. This could have resulted in under-reporting of the state of crashes in the country. The study additionally involved only a month period during the 2022 December festive season. The results may thus not be generalisable to trends observed over an extended period. The study further only recorded patients who were admitted to the hospital, patients who were injured but not admitted were not captured thus may further contribute to under-reporting.

### **Conclusion**

MVCs continue to be a major contributor to trauma morbidity and mortality globally with a significant burden of disease. The study described MVCs over a month period during the festive season in Namibia. The festive season in the country is associated with an increase in MVCs and subsequently injuries due to an increase in traffic volumes and hence the selection of the study period. Economically active males are part of the population mainly involved in MVCs with consequent socio-economic effects. The study found males between the ages of 31-35 years

were the most injured. Evidence suggests that men behave riskier than their female counterparts hence the higher involvement in MVCs. The cost of the medical management of the 87 patients included in the study was over N\$ 15 million, a significant amount over a month period.

The study highlights various aspects that may require further study to understand such as the high incidence of pedestrians in crashes and the hotspots identified in the study. Targeted interventions are needed to be developed in an attempt to reduce the crash burden of the country. Furthermore, effective emergency care can alleviate most trauma morbidity and mortality. An evaluation of the EMS in the high crash zones is required to reduce any gaps in accessing emergency care.

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## **Part C: ADDENDA**

### **Instructions to Authors**

The journal selected for publication is the African Journal of Emergency Medicine. Instructions to authors of the journal can be accessed at <https://www.sciencedirect.com/journal/african-journal-of-emergency-medicine/publish/guide-for-authors>.

## Research Protocol



### **An Epidemiological Study of Motor Vehicle Crashes in Namibia**

A research proposal submitted in partial fulfilment of the requirements for the award of the

Master of Philosophy: Emergency Medicine

University of Cape Town

Student Name: Paulus Ambunda

Student Number: AMBPAU001

Supervisor: Dr. Lauren Lai King

Co-Supervisor: Dr. Willem Stassen

Co-Supervisor: Dr. Kaveto Sikuvi

## Table of Contents

Introduction .....	3
Road traffic injuries and the burden of disease .....	4
Cost of MVCs in Africa .....	4
Research Aim and Objectives .....	5
Research Aim .....	5
Specific Objectives .....	5
Research Methodology .....	5
Research Design .....	5
Study Setting .....	6
Study Population .....	6
Sampling Strategy .....	7
Data Collection .....	7
Data Analysis .....	8
Data Management .....	9
Ethical Considerations .....	9
Project Strengths and Limitations .....	9
Budget .....	11
References .....	13
Appendix 1 .....	14
Appendix 2 .....	15

## **Introduction**

Motor vehicle crashes (MVCs) have become a public health concern and contribute significantly to the morbidity and mortality of trauma patients globally.(1) In a study published in the year 2004, it was estimated that over 1.2 million people were killed in motor vehicle crashes in the world while over one million people were injured or left disabled.(2) This translated to 3.6 percent of the global mortality burden as a result of MVCs.(3) In the year 2004, MVCs were estimated to have accounted for 2.7 percent of the total disability-adjusted life years (DALY) worldwide, a figure that is forecast to increase to 4.9 percent by the year 2030 and therefore places MVC related injuries as the third leading cause of the global disease burden.(3) In 1998, MVC related injuries were ranked as the 9<sup>th</sup> leading cause of the global disease burden and in 2020, this ranking has increased to the 3<sup>rd</sup> position.(4) This indicates a trend towards the predicted ranking in 2030.

In high income countries (HICs), the burden of motor vehicle crashes is decreasing, and this is attributed to multiple factors such as enhancements in pre-hospital care and emergency medicine to name a few.(5) The disease burden is however increasing in low and middle income countries (LMICs). This increase is associated to the development of road systems in LMICs which has resulted in an increase in MVCs and related injuries.(3) LMICs are said to carry approximately 90 percent of the MVC related injuries' disease burden with about 205000 fatalities and 7 151 000 DALYs secondary to MVCs.(3) This translates to 969 DALYs per 100 000 in Africa while the global DALY rate is at 640 DALYs per 100 000 population. This indicates the magnitude of the burden in Africa.

Namibia is a Sub-Saharan country located on the southern end of Africa and has a high number of MVCs. In the year 2016, the World Health Organization (WHO) estimated the MVC related mortality rate of Namibia to be 30.6 per 100 000 population.(6) Like many other African countries, Namibia's healthcare sector is low resourced and burdened by a high number of MVCs. There is however limited published data describing the burden of MVCs in the country.

Additionally, Namibia is a vast country and distances between towns are large. Given the high MVC rate, placement of emergency services is of utmost importance. To date, there is no known

study describing the distribution of ambulances nor a geospatial analysis of MVCs in Namibia that can potentially inform health resources allocation.

## **Literature Review**

### **Road traffic injuries and the burden of disease**

Globally, road traffic injuries are the 8<sup>th</sup> leading cause of mortality in all age groups and has now been found to be the leading cause of mortality in children and young adults within the age groups of 5-29 years.(6) Progress has been reported in some areas of the world which have seen reductions in MVC related injuries and deaths.(6) This progress has however not been equal globally, with some parts of the world experiencing increases in MVC related injuries and deaths.(6) Despite the progress made, it has not been fast enough to meet the sustainable development goal (SDG) target 3.6 which aimed to reduce the number of road traffic deaths by a half by the year 2020. The global road traffic mortality rate was 18.2 deaths per 100 000 population in 2016.(6) The African rate was at 26.6 per 100 000, making Africa the continent with the highest road traffic mortality rate in world.

Most African countries fall within the classification of LMICs. In many parts of Africa, road traffic related deaths remain under-reported due to absent or poor data capturing systems.(7) The absence of such systems has a direct negative impact on healthcare planning. South Africa, a neighbouring country to Namibia had a reported MVC related mortality rate of 27 per 100 000 population, which is well over the African rate and the global rate of 18 per 100 000 population.(6, 8) This indicates the heavy burden of MVCs on the African continent however, despite the burden, epidemiological studies are lacking on the African continent with only 39 published studies describing the burden of road traffic injury from 15 countries over a period of 35 years (1980-2015) were found in a systematic review and meta-analysis conducted in 2015.

### **Cost of MVCs in Africa**

MVC injuries are associated with a significant financial burden to countries due to high cost involved in the medical management of MVC injured patients. The annual financial cost of MVC related injuries was reported to be over USD \$518 billion globally and over USD \$65 billion in

LMICs.(9) This was based on data published in the year 2000. In the year 2012, MVC related injuries accounted for USD \$10.5 billion in healthcare expenses in South Africa, equivalent to about 3% of the country's gross domestic product (GDP).(8) Most of the data is however over a decade old and there has been a call for more recent data particularly on the African continent and in LMICs.(3) In a recent study on adult patients with severe traumatic brain injury (TBI) secondary to MVCs in two Namibian regions, the associated medical cost of managing 87 patients was USD \$1 865 251.34 over a 5 year period.(10) This study provided an indication of the financial burden that MVCs carry as the study although limited, presented only medical costs of patients who sustained severe TBIs in 2 Namibian regions over the stipulated period.

### **Research Aim and Objectives**

#### **Research Aim**

The research study aims to describe the epidemiological characteristics of motor vehicle crashes in Namibia over the 2022 festive season period, a 1-month period (December 2022).

#### **Specific Objectives**

- Describe the epidemiology of MVCs and associated patient demographics and profile of injury
- Describe the geo-spatial data of MVCs in the country over a 1-month period by plotting the location of MVCs on a map for the festive season period (December 2022)
- Describe the healthcare cost associated with the MVCs over a 1-month period for the 2022 festive season period (December 2022)

#### **Research Methodology**

##### **Research Design**

A descriptive observational study, in the form of a retrospective review, will be conducted to describe the epidemiological characteristics of MVCs in Namibia over a 1-month period during the 2022 festive season period (December 2022).

### **Study Setting**

The study will be conducted in Namibia in MVCs that resulted in injury to the persons involved. Namibia is a southern African country bordering the Republic of South Africa in the south, Botswana in the east and Angola in the north.(11)

The country has an estimated population of 2.5 million as of the year 2020 and is divided into 14 regions. (12) Between the years 2015 and 2019, 19 814 crashes with injuries were recorded.(12, 13, 14, 15) while 8 992 crashes with injuries were recorded between the years 2020 and 2022.(16)

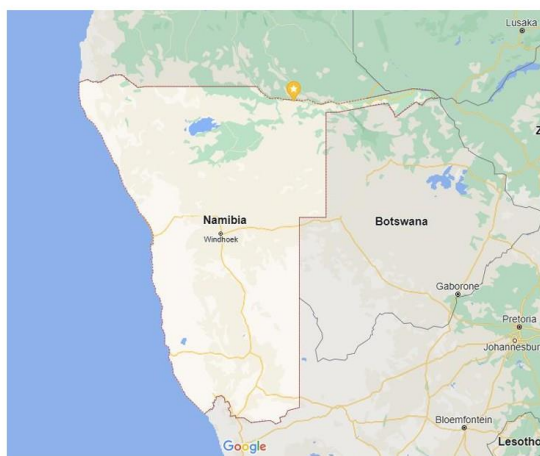


Figure 1. Namibia

### **Study Population**

The study population will be all MVC recorded by the MVA Fund over a 1-month period during the December 2022 festive season period. MVC in the study context are all crashes involving motorised vehicles inclusive of pedestrian-vehicle crashes where persons are injured.

The festive season in Namibia sees a rise in the traffic volumes on the national roads due to the travelling of people to holiday destinations. Due to the high traffic volumes, there is normally an increase in crashes on the roads and resultant injuries.

### **Sampling Strategy**

From the MVA Fund database, all crashes that meet the inclusion criteria will be selected.

#### **Inclusion criteria:**

- All crashes recorded on the Siebel system (MVA Fund in-house production system) that occurred between 01 December 2022 and 31 December 2022.

#### **Exclusion Criteria:**

- Crashes not recorded on the Siebel system
- Incomplete crashes recorded on the Siebel system (missing data points)

### **Data Collection**

Data will be collected from MVA Fund database by the principal investigator. The MVA Fund is a state-owned company in Namibia established under the Parliamentary Act, Motor Vehicle Act no.10 of 2007. The MVA Fund is mandated to design, promote and implement injury prevention strategies and provide assistance to all persons injured in MVCs.(14) As part of the mandate, the MVA Fund operates a 24-hour National Emergency Communications Centre (ECC) through which emergency services (police, emergency medical rescue services) are dispatched and coordinated.

The MVA Fund, primarily through the ECC therefore only records crashes which result in injuries and fatalities. (17) The recorded data is verified with the Namibian police service, ambulance service providers who respond to the scene of the crash and with medical facilities to which the patients are transported for further management.(17) To ensure data accuracy, the MVA Fund's business unit responsible for data draws weekly reports to assess for missing data points in the recorded crashes. Any incomplete crashes are sent to the ECC to follow up with the said stakeholders and complete the missing data points.

The MVA Fund system will be used to determine crash characteristics (location, time of day, crash type, cause of crash, vehicle types, purpose of vehicle) and patient data (sex, age, injuries, health facility, healthcare costs). Injuries will refer to the physical harm that a patient has sustained as a result of the MVC and health facility will be a physical location in which healthcare is provided to the patient as a result of the injuries sustained in the MVC. The injuries will be extracted from

the MVA Fund database as recorded on the system (ICD-10 codes and manual injury entries). The data collected will be organised and cleaned in a 2013 Microsoft Excel spreadsheet (Microsoft Corporation, Washington, United States).(18)

Cases will be selected according to the inclusion criteria described above. Key variables will be defined in a data dictionary to ensure that a consistent understanding is maintained amongst all involved in the project. (*Appendix 1*) A standard excel spreadsheet will be designed and used for capturing the research data and regular meetings will be held with the research team throughout the data collection period to ensure that the research is conducted according to the approved protocol and ensure early detection of deviations.

### **Data Analysis**

The cleaned data will be imported to the SPSS statistical package, Version 25 (IBM Corp., Armonk, New York, United States) for statistical analysis. For descriptive statistics, measures of frequency (count, proportion and percentages), measures of central tendency (mean, median, mode), measures of dispersion (range, variance and standard deviation) as well as measures of position (interquartile ranges) will be calculated as appropriate for the type of data (categorical or numerical) and presented in tables and graphs. Frequency data will be expressed as incidence.

For the temporal analysis, distribution of MVCs according to time of day, day of the week and month of the year will be subjected to chi-squared testing or another appropriate non-parametric testing. A significance level of 95% ( $p < 0.05$ ) has been set. Data analysis will be supported by a statistician if beyond the scope of the supervisors to assist.

The geospatial analysis will be performed using the location data variables. If needed, data will be geocoded using the ESRI World Geocoder in ArcGIS Online (Esri, California, United States). Data will be subjected to cluster and outlier analysis (Anselin Moran's I) to identify clusters with statistically significantly higher and lower incidence. Hotspot analysis (Getis-Ord Gi) will be performed on the data aggregated by hexagonal tessellation (4 km<sup>2</sup>/hexagon). Finally, proximity analysis will be used to determine the projected driving time from each MVC location to the closest facility. All geospatial analyses will be performed using ArcGIS Pro 2.6.3 (Esri, California,

United States) and ArcGIS Online (Esri, California, United States). The UCT library GIS consultancy will be approached for support.

### **Data Management**

All data pertaining to the research project will be stored on the researcher's password protected personal laptop. Data will be backed up and kept secure on a password-protected encrypted physical drive and a password-protected cloud-based encrypted drive. Access to the data will be limited to the researcher, statistician, and the supervisors.

### **Ethical Considerations**

To gain access to the MVA Fund database, written permission will be requested from the MVA Fund (see Appendix 2). The proposal will be submitted to the UCT Human Research Ethics Committee (HREC) and the Namibian Ministry of Health and Social Services (MoHSS) ethical committee for approval. A waiver of informed consent will be sought from the UCT ethics committee as it is not feasible to gain consent from the patient's whose data will be accessed in the databases.

During data collection, in order to respect patient confidentiality and anonymity, no identifiable data will be captured and only the principal investigator will have access to patient identifiable data on the production system. Due to the retrospective nature of the study, and that no identifying information will be obtained, informed patient consent will not be feasible. Data will be stored on an external hard drive in a password-protected encrypted folder.

### **Project Strengths and Limitations**

To our knowledge, the study will be the first to describe the epidemiological characteristics of MVCs in the country. The study will include all crashes that occurred during the 2022 December festive season period in the country and will therefore provide epidemiological data for this period in the country that is commonly associated with an increase in MVCs due to increased travelling to holiday destinations. The study will also include geo-spatial data of crashes in the country which may indicate crash hotspots in the country and prompt further reasons on the

cause of crashes in the hotspots. This data could potentially guide healthcare planning for these seasons.

The study will describe the epidemiological characteristics of trauma patients secondary to MVCs only. The study will therefore not include injuries sustained from other mechanisms other than MVCs. Data will be collected from one source only, the MVA Fund database. A possibility of under-reporting therefore exists as crashes in which injuries were sustained but were not recorded by the MVA Fund will not be included in the study. This risk is, however, low as the MVA Fund collects the data primarily through the ECC to which all crashes in the country are reported. The ECC therefore co-ordinates these crashes from the acute stage to hospital admission and verifies information with hospitals and emergency service providers to ensure data accuracy.

The MVA Fund captures crashes in which injury to a person has occurred, the study will therefore not describe all crashes that occurred in the timeframe but only those that resulted injury to the persons involved.

#### **Significance of Research**

MVCs are a public health concern and are significant contributors to mortality and morbidity among trauma patients. MVCs have been recognised to be the leading cause of mortality among the paediatric population. The MVA Fund between the year 2015 and 2019 spent over N\$845 million for the medical management of patients injured in MVCs.(12, 13, 14, 15) The financial burden is higher as the figure above does not include other benefits paid out by the MVA Fund such as funeral grants, injury grants, loss of support and loss of income. Although low resource countries carry the largest burden of disease from MVCs, epidemiological data from these countries is lacking due to few studies conducted. Epidemiological data is required to inform healthcare planning and lack thereof can result in improper planning.(1)

As stated earlier, the festive season in Namibia is associated with an increase in crashes and commonly injuries. In an effort to curb this increase and associated results, the MVA Fund in partnership with various road safety stakeholders operate an annual festive season road safety campaign during the month of December. The campaign focuses on increasing traffic policing and emergency response capacity in strategic areas of the country. (16) Apart from the published

statistics from the MVA Fund, no epidemiological data is available that could guide health planning and resource allocation. This study could therefore be a platform to develop further research that will describe epidemiological trends in more detail.

There are no known published studies describing the epidemiology of MVCs in Namibia. The study will therefore:

- Provide an epidemiological study of MVCs in Namibia and establish the extent of the burden of MVCs in the country
- Potentially guide healthcare planning
- Develop a platform for further research

It is against this background that the study aims to describe the epidemiological characteristics of MVCs in Namibia.

#### **Dissemination of Findings**

The dissertation generated from this work will be hosted open access on UCT's institutional repository, OpenUCT. A report will be compiled and presented to the Motor Vehicle Accident Fund of Namibia through the Chief: Human Capital and Strategy, the responsible person for research approvals at the organisation. The study and its findings will be developed into a research article manuscript for submission to a peer-reviewed journal and will be submitted for presentation at local and international conferences as oral and poster presentations.

#### **Budget**

The estimated total budget for the project is N\$ 4,000.00. This amount will be used to cover expenses for the statistician. The estimated budget will be self-funded.

### Timeline

Activity description	01 July 2023	01 July 2023	31 July 2023	15-31 July 2023	01 August-31 August 2023	01 September-20 September 2023	21 September-25 November 2023	31 November 2023	01 December 2023-30 January 2024
Research Proposal Submission									
Get ethical approval from UCT and MoHSS									
Get approval to conduct research from the MVA Fund									
Data collection									
Data analysis									
Literature review									
Begin research write-up									
Complete research write-up									
Submit final research report									

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## **Appendix 1**

### **Data Dictionary**

Injuries: physical harm and description of body area(s) affected as a result of the MVC. Injuries will be captured as physical description and or ICD-10 codes where available.

Injury severity: triage classification at the scene of the MVC

Health facility: The facility to which a patient was transported to from the scene of crash for treatment.

Date: day/month/year recorded by the MVA Fund as when the crash occurred.

Time: time the crash occurred as recorded by the MVA Fund

Location: The geographical point at which the crash occurred as captured by the MVA Fund. This will be recorded as outside a town or inside town, exact location including street address and GPS coordinates to be included if available

Sex: Male or female

Age: age of the involved persons in years

Costs: The direct financial cost of the medical management (ambulance & hospital bills) of the patient from an MVC. This will be recorded as a total amount of ambulance and hospital costs and excludes the injury grants, funeral claims and any other costs that is not a direct medical cost.

## **Appendix 2**

### **MVA Fund Request Letter**

Paulus Ambunda  
P. O. Box 27986  
Windhoek  
Namibia  
14 August 2023

Mr Julius Haikali  
Chief Human Capital and Strategy  
Motor Vehicle Accident Fund  
P. O. Box 25158  
Windhoek

#### **RE: REQUEST TO CONDUCT RESEARCH**

Dear Mr Haikali

My name is Paulus Ambunda, and I am a student at the University of Cape Town (UCT) enrolled for a Master's Degree of Philosophy in Emergency Medicine. The research I wish to conduct for my dissertation is titled: An epidemiological study of Motor Vehicle Crashes in Namibia. The study aims to describe the epidemiological characteristics of motor vehicle crashes in Namibia over a 1-month period (December 2022).

This project will be conducted under the supervision of Dr. Lauren Lai King, Dr Willem Stassen and Dr Kaveto Sikuvi and is in part fulfilment of the Master's Degree in Emergency Medicine.

I hereby seek your consent to access data relating to motor vehicle crashes during the December 2022 period recorded by the MVA Fund. Attached is a copy of my research proposal detailing how the research will be conducted. All data accessed will be treated confidential and will only be shared with the supervisor and biostatistician.

Upon completion of the study, I undertake to provide the MVA Fund with the full research report and recommendations, if any. If there are any queries, please do not hesitate to contact me on 0853896757 or via e-mail at AMBPAU001@myuct.ac.za.

Yours sincerely,  
Paulus Ambunda

## HREC approval letter



**UNIVERSITY OF CAPE TOWN**  
**Faculty of Health Sciences**  
**Human Research Ethics Committee**



**Room 45 E-52-E-Floor- Old Main Building**  
**Groote Schuur Hospital**  
**Observatory 7925**  
**Telephone [021] 406 6492**  
**Email: [hrec-submissions@uct.ac.za](mailto:hrec-submissions@uct.ac.za)**  
**Website: [www.health.uct.ac.za/home/human-research-ethics](http://www.health.uct.ac.za/home/human-research-ethics)**

15 September 2023

**HREC REF: 669/2023**

**Dr L Lai King**  
Division of Emergency Medicine  
F-51 OMB  
Email: [lauren.laiking@uct.ac.za](mailto:lauren.laiking@uct.ac.za)  
Student: [ambpau001@myuct.ac.za](mailto:ambpau001@myuct.ac.za)

Dear Dr King

**PROJECT TITLE: AN EPIDEMIOLOGICAL STUDY OF MOTOR VEHICLE CRASHES IN NAMIBIA-  
MASTERS CANDIDATE-MR PAULUS AMBUNDA**

Thank you for submitting your study to the Faculty of Health Sciences Human Research Ethics Committee (HREC) for review.

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study, subject to the local approvals.

The HREC note that geo-spatial data will be collected, and we understand why. Please mitigate any risk of stigma for communities during publication.

**Approval is granted for one year until the 30 September 2024.**

Please submit a progress report, using the standardised Annual Progress Report Forms (FHS016) or (FHS 017) if the study continues beyond the approval period. Please submit a Standard Closure form (FHS 010) when the study has been completed, this includes after publication or thesis submission and final completion.  
(Forms can be found on our website: [www.health.uct.ac.za/fhs/research/humanethics/forms](http://www.health.uct.ac.za/fhs/research/humanethics/forms))

***The HREC acknowledge that the student: Mr Paulus Ambunda also be involved in this study.***

**Please quote HREC REF 669/2023 in all your correspondence.**

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please note that for all studies approved by the HREC, the principal investigator **must** obtain appropriate institutional approval, where necessary, before the research may occur.

Yours sincerely

Signed by candidate

**PROFESSOR M BLOCKMAN**  
**CHAIRPERSON, FACULTY OF HEALTH SCIENCES HUMAN RESEARCH ETHICS COMMITTEE**

HREC/ref 669.2023

# Ministry of Health and Social Services Ethics Approval Letter



REPUBLIC OF NAMIBIA

## MINISTRY OF HEALTH AND SOCIAL SERVICES

Ministerial Building  
Harvey Street  
Private Bag 13198, Windhoek

OFFICE OF THE EXECUTIVE DIRECTOR

Tel: No: 061 -203 2507  
Fax No: 061-222 558  
Andreas.Shipanga@mhss.gov.na

**Ref:** 22/4/2/3

**Enquiries:** Mr. A. Shipanga

**Date:** 10 October 2023

**Mr. Paulus Ambunda**  
**PO Box 27986**  
**Windhoek**  
**Namibia**

Dear Mr. Ambunda

**Re: An epidemiological study of motor vehicle crashes in Namibia.**

1. Reference is made to your application to conduct the above-mentioned study.
2. The proposal has been evaluated and found to have merit.
3. **Kindly be informed that permission to conduct the study has been granted under the following conditions:**
  - 3.1 The data to be collected must only be used for academic purpose;
  - 3.2 No other data should be collected other than the data stated in the proposal;
  - 3.3 Stipulated ethical considerations in the protocol related to the protection of Human Subjects should be observed and adhered to, any violation thereof will lead to termination of the study at any stage;
  - 3.4 A quarterly report to be submitted to the Ministry's Research Unit;
  - 3.5 Preliminary findings to be submitted upon completion of the study;
  - 3.6 Final report to be submitted upon completion of the study;
  - 3.7 Separate permission should be sought from the Ministry for the publication of the findings.
4. All the cost implications that will result from this study will be the responsibility of the applicant and **not** of the MoHSS.

Yours sincerely

Signed by candidate

**BEN NANGOMBE**  
**EXECUTIVE DIRECTOR**



All official correspondence must be addressed to the Executive Director.



22507

# MVA Fund Approval Letter



MVA Fund Service Centre, 8730 Church Street, P.O. Box 25158, Windhoek, Tel: +264 61 289 7000, Fax: +264 61 249 688

Monday, 02 October 2023

Mr. Paulus Ambunda  
P.O Box 27986  
Master of Philisophy in Emergency Student  
University of Science and Technology  
**WINDHOEK**

Dear Mr. Ambunda

## REQUEST FOR DATA ON MOTOR VEHICLE ACCIDENTS

The subject matter refers,

This letter serves to confirm receipt of your letter dated 26 September 2023, wherein you requested for consent to obtain data from the MVA Fund on "Epidemiological study of motor vehicle crashes in Namibia over a 1-month period during December 2022".

I wish to inform you that your request has been approved, on condition that the data will strictly be used for academic purposes and that, it should not be disclosed or shared with the public without expressed written consent by the MVA Fund.

I trust that the above is in order and wish you a fruitful research.

Yours Sincerely,

Signed by candidate

**JULIUS HAIKALI**  
**CHIEF HUMAN CAPITAL & STRATEGY**

JH/eh



Directors:  
Dr Shitaleni Herman (Chairperson), Jantje Daun (Deputy Chairperson), Elizabeth Kharuchas,  
Magnus Nangombe, Namene Shejavali, Damien Mabengano, Tomas Lindji,  
Rosalia Martins-Hausiku - Chief Executive Officer (ex officio)

