PROFILE OF PEDESTRIAN ROAD TRAFFIC CRASH FATALITIES ON THE R71 ROAD ADMITTED AT POLOKWANE FORENSIC PATHOLOGY SERVICES

by

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MINI-DISSERTATION

Submitted in partial fulfilment of the requirements for the degree of

MASTER OF MEDICINE

in

FORENSIC PATHOLOGY

in the

FACULTY OF HEALTH SCIENCE

(School of Medicine)

at the

UNIVERSITY OF LIMPOPO

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2022

DEDICATION BY STUDENT

This work is dedicated to my mother, husband and two children (Ofentse and Omphile).

DECLARATION

I declare that the mini-dissertation hereby submitted to the University of Limpopo, for the degree of Master of Medicine in Forensic Pathology has not previously been submitted by me for a degree at this or any other university; that it is my own work in design and execution, and that all material contained herein has been duly acknowledged.

Mphatja TW 25 April 2022

ACKNOWLEDGEMENTS

I would like to thank the following persons for their respective contributions to this dissertation:

- Firstly, I thank the Lord for giving me strength to press on despite the challenges encountered.
- My husband, Dr Thabo Shongwane, for his love and support.
- My son Ofentse Shongwane, for being understanding, supportive and for endless prayers.
- A special thank you to Dr MJ Selatole (supervisor) and Dr MI Hlahla (co-supervisor) for guidance, patience and encouragement when all hope was lost.
- To Mr P Mphegwana (statistician), for his valuable input in the research.
- To Mr Joe Matsapola (South African Weather Services) for his assistance in data collection.
- To Polokwane Medical Records (Mrs Loggenburg and Mrs Mavis Lefifi) and Mankweng Medical records (Mrs Mangoato), for assistance with medical records.
- To Polokwane Forensic Pathology Services, for the assistance with the dockets.
- To Prof. TW Molotja for proofreading and editing the document.

ABSTRACT

Introduction and background: Road traffic fatalities remain a worldwide burden with more than half of those fatalities comprising of vulnerable road users (pedestrians, cyclists and motorcyclists). This prompted the World Health Organization and United Nations to establish Sustainable Developmental Goals aimed at reducing road traffic crashes. The study explored factors relating to pedestrian fatalities on the R71 road, which may inform future interventions to enhance pedestrian safety.

Aim: The study aimed at profiling pedestrian road traffic crash fatalities on the R71 road admitted at Polokwane Forensic Pathology Services.

Methodology: A quantitative descriptive study utilising total population purposive sampling of pedestrians that demised because of R71 road traffic crashes over a 3-year period was done. There were 65 cases studied.

Results: The study revealed that the fatalities were more male adult pedestrians than females, who were between 20 -39 years old. Majority of those pedestrians were wearing dark coloured clothing with no reflectors on. The pedestrian fatalities were mostly seen over the weekend and between evening and midnight. The fatalities peaked in December and February (summer season). The common locality of the pedestrian fatalities was Mankweng and Mentz village (Area 3). Most of those pedestrians sustained head injuries.

Conclusion: Contributory factors and injuries of those pedestrian fatalities that demised because of R71 road traffic crashes were identified, which some were similar to those already highlighted in literature.

Key concepts: Fatality, Pedestrian, Road Traffic Crash, R71 road

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DEFINITION OF CONCEPTS

Fatality: a death caused by an accident, violence, war or disease (Oxford Dictionary, 2006). Road Traffic Management Corporation (RTMC, 2018) defines fatality in relation to road crashes as deaths of a person or persons during or immediately after a crash or within 30 days following direct complications of such a crash. As used in the study, fatalities refer to pedestrians that demised following road traffic crashes on the R71 road or following complications of such a crash, however the 30 days duration was not applicable in the study as hospital admissions and complications may still be evident beyond 30 days.

Pedestrian: This refers to a person who is travelling by walking and may include those using various modifications and aids such as wheelchairs, motorized scooters, walkers, canes, roller blades and skateboards (WHO, 2013). In the study, pedestrian referred to a person that is travelling by walking, regardless of modification.

Road traffic crash: a collision involving at least one road vehicle in motion resulting in at least one person injured or killed. This definition includes collisions of road vehicles or road vehicle with a pedestrian, animal, fixed object or obstacle, a road vehicle alone or at the railway (WHO, 2013). In the study, road traffic crash referred to road traffic crashes on the R71 road.

R71 Road: R71 is a Provincial road in Limpopo Province. The road starts at N1 bypass in Polokwane (Google maps, accessed on 07/07/2020) then proceeds to Haenertsburg and ending at Phalaborwa gate at Kruger National Park (Falkner, 2012). R71 in the study referred to the area between Polokwane (from the N1 bypass) and Haenertsburg.

Diffuse axonal injuries: Widespread damage of axons (Saukko & Knight, 2016) grossly seen as small haemorrhages seen in the corpus callosum, sub-cortical cerebral white matter (particularly peduncles), cerebellar white matter and diencephalon of the midbrain or pons (Spitz & Fisher, 2006). In the study,

diffuse axonal injury referred to gross features or diagnosis as described in the clinical notes.

Cervical spine injuries: Upper cervical spine injuries involve C1-C2 while fractures involving the rest of the cervical spine are low cervical spine injuries (Guirgis, Menon, Suri, Chatterjee & Attallar, 2016). In the study, the definition remained the same.

Children: The WHO defines children as anyone below the age 19, and within that category, 10 year olds to 19 year olds are classified as adolescents (WHO, 2016). The definition remained the same in this study.

Adult: Anyone above the age of 19 years shall be regarded as an adult (WHO, 2016). The definition remained the same in the study.

LIST OF ABBREVIATIONS

WHO: World Health Organization

PFPS: Polokwane Forensic Pathology Services

RTMC: Road Traffic Management Corporation

NIMSS: National Injury Mortality Surveillance System

WCIMP: Western Cape Injury Mortality Profile

CHAPTER 1

INTRODUCTION, BACKGROUND AND ORIENTATION OF THE STUDY

1. 1 INTRODUCTION AND BACKGROUND

Road traffic fatalities remain a worldwide burden with more than half of them comprising of vulnerable road users (pedestrians, cyclists and motorcyclists) (WHO, 2018). Globally, pedestrians and cyclists represent 26% of all road traffic deaths. The largest proportion of these pedestrian and cyclist mortalities are observed in Africa, and comprises 44% of all road traffic deaths (WHO, 2018).

Road Traffic Management Corporation (2018) reports that pedestrians and passengers are the mostly affected in road traffic crashes in South Africa. Detailed breakdown of pedestrian fatalities per province is not included in the report. However, the Western Cape Injury Mortality Profile (WCIMP) reports that pedestrian deaths represent 45% of all road traffic deaths in Western Cape Province (WCIMP, 2018). The National Injury Mortality Surveillance System (NIMSS) for Gauteng and Mpumalanga Provinces show that pedestrian deaths represented 41.2% of all road traffic deaths in Gauteng Province and 29.2% in Mpumalanga Province (NIMSS, 2013). There were no similar reports for other provinces including Limpopo Province. Statistics South Africa (2017) only details deaths due to transport accidents and makes no mention of pedestrian deaths as an entity.

There is therefore no detailed report on pedestrian fatalities in the different districts of Limpopo province. The researcher however, observed in their area of practice that there seemed to be several pedestrian fatalities on different roads in the Capricorn district admitted to their facility of practice at Polokwane Forensic Pathology Services (PFPS) for autopsies, and many with severe injuries that may be attributable to high speeds. One such road is the R71 road running through several small villages. A previous study highlighted road infrastructure issues on the R71 road as one of the contributory factors of pedestrian fatalities (Mokoma, 2017). In 2015, upgrades on the R71 road next

to Moria were completed to reduce traffic congestion and improve pedestrian and motorist safety. These upgrades included dualling of carriageways, widening of shoulders, pedestrian walkway in the shoulder and interchange, arched concrete bridge and median lighting (SANRAL, 2015). Despite these upgrades, several fatalities on the road are still being admitted to PFPS. This raised interest regarding other possible contributory or risk factors (pedestrian factors, environmental factors) that can be improved upon or eliminated in order to improve road safety of pedestrians.

Successful interventions to protect pedestrians are possible with a good understanding of factors involved (WHO, 2013). Contributory factors are multifactorial, and thus these interventions should target pedestrians, drivers and road infrastructure. This is in line with Sustainable Development Goals (SDG) target 3.6 established by the World Health Organization (WHO) and United Nations (UN), which aims to reduce road traffic mortality by half in 2020 and SDG target 11.2, which aims to improve road safety, promoting safer vehicles and safer road users by 2030 (WHO, 2011).

In an attempt to identify some of these factors, the research profiled pedestrians through a quantitative descriptive study utilising total population purposive sampling of pedestrians that demised because of R71 road traffic crashes between 1 January 2017 and 31 December 2019 and admitted in Polokwane Forensic Pathology Services.

The study showed majority of pedestrian fatalities on the R71 road involved males more than females. The fatalities were mostly seen in adults aged between 20 -39 years of age. Majority of those pedestrians were reported to be wearing dark coloured clothing with no reflector on. The pedestrian fatalities occurred throughout the week, with more fatalities seen over the weekend and between evening and midnight. The fatalities were seen throughout the year, but peaked in December and February months, which are summer months. The majority of the accidents were reported between Mankweng and Mentz village

(Area 3) followed by Nobody to Mamadimo Park/ Moremadi Park (Area 2). Within those areas, are residential areas, a mall, schools and liquor outlets within close proximity to the road. The pedestrians sustained mostly head injuries with majority having intracranial injuries. This was followed by a high occurrence of chest injuries and lower limb injuries.

1.2. RESEARCH PROBLEM

Pedestrian fatalities in road traffic crashes are a global problem, with more fatalities in developing countries. This prompted the WHO and the UN to include SDG that aimed to reduce road traffic crashes by improving road safety, promoting safer vehicles and safer road users. PFPS continues to admit several pedestrian fatalities for autopsies from different roads in the Capricorn district, one such road being R71, which interestingly had significant road upgrades to enhance safety in 2015. In 2018, approximately 27 cases were admitted from the R71 road to PFPS in the first 6 months of that year.

Although there are documented interventions, which can be applied with good understanding of factors involved in pedestrian road traffic crashes, there is not much literature highlighting these factors in our local setting. This study explored these factors relating to R71 road fatalities, which may in future be able to inform intervention measures to enhance road safety.

1.3 AIM OF THE STUDY

The study aimed at profiling pedestrian road traffic crash fatalities on the R71 road admitted at Polokwane Forensic Pathology Services (PFPS).

1.4 OBJECTIVES

To achieve its aim, the study had the following objectives:

- To explore the contributory factors of pedestrian road traffic crash fatalities on the R71 road, namely pedestrian factors, environmental factors and locality of the crashes.
- To describe the types of injuries of pedestrian road traffic crash fatalities on the R71 road.

1.5 RESEARCH QUESTIONS

The study aimed to answer the following questions:

- What are the contributory factors of pedestrian road traffic crash fatalities on the R71 road?
- What is the pattern of injuries of pedestrian road traffic crash fatalities on the R71 road?

1.6 SIGNIFICANCE OF THE STUDY

The study aimed to profile pedestrian road traffic crashes on the R71 road so that pedestrian safety is improved. It also aimed at identifying any gaps in the current guidelines of pedestrian safety. Secondly, literature had shown that there is insufficient information in the related field, so the study was also meant to assist with a detailed report of pedestrian fatalities. The findings of the study may be disseminated to the Department of Health Limpopo Province, Public Health, Department of Roads and Transport, Road Agency Limpopo and SANRAL. The researcher believes that by so doing, this multidisciplinary team approach may assist to implement different intervention strategies to reduce pedestrian fatalities on the R71 road. This may be done through continuous pedestrian safety awareness campaigns, improve road safety, and perhaps identify any areas of improvements with regards to road infrastructure on the R71 road.

1.7 CONCLUSION

The chapter provided an introduction and background of the study. It further explained the aims and objectives of the study, as well as the significance of conducting this study and the desired outcomes. The next chapter will outline the literature reviewed.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Pedestrians constitute one fifth of the global road traffic injury deaths (WHO, 2013). Pedestrian injuries and fatalities are higher in developing countries than in developed countries (Damsere-Derry, Ebel, Mock, Afukaar & Donkor, 2010). Walking is a means of transport in developing countries, whereas in developed countries walking is mostly for leisure and exercise (Damsere-Derry et al., 2010).

Globally, 36% of pedestrian road traffic fatalities occur in low-income countries, 22% in middle-income countries and 18% in high-income countries in relation to other road users (WHO, 2013). The highest proportion of these pedestrian deaths (38%) in relation to other road users is being observed in the African region (WHO, 2013). The Road Traffic Management Corporation (RTMC), which details overall statistics of road traffic crashes in South Africa, reports that pedestrian deaths represent 38% of total road traffic deaths (RTMC, 2018). There was, however, insufficient local research on pedestrian fatalities and associated contributory factors.

Contributory factors of pedestrian fatalities are multifactorial, and it is important to have an understanding of these factors, and how they are interlinked with pedestrian fatalities. This will assist in the design and prioritization of measures meant to improve the safety of pedestrians (Martinez-Ruiz, Valenzuela-Martinez, Lardelli-Claret, Molina-Soberanes & Moreno-Roldan, 2019). The type of injuries and severity, for instance, may suggest the speed of impact, and therefore speeding as a factor (Hussain, Feng, Grzebieta, Brijs & Olivier, 2019). Knowledge of these factors will assist in targeted interventions in line with the Sustainable Development Goals (SDG) target 3.6 and 11.2 that are established to reduce these pedestrian mortalities (WHO, 2011). Interventions to reduce

these fatalities are well documented and should be implemented. These interventions could start with awareness campaigns by public health regarding safer practices by both pedestrians and vehicle drivers in order to change their behaviour on the road (Chong, Chiang, Allen Jr, Fleegler & Lee, 2018). Interventions are not always possible but are necessary to improve road safety. The literature review will outline the risk factors /contributory factors associated with pedestrian fatalities and types of injuries sustained by pedestrians.

2.2. CONTRIBUTORY FACTORS

Literature identified various risks or contributory factors of pedestrian road traffic fatalities. Knowledge and understanding of such factors is necessary in order to develop targeted interventions. These factors include individual/ pedestrian factors, driver factors, environmental factors, as well as road factors (Damsere-Derry et al., 2010; Mansfield, Peck, Morgan, McCann & Teicher, 2018).

Individual/ human factors

Pedestrian factors

- Gender and age

Male pedestrians are found to be overrepresented in both adults and children (WHO, 2013). This trend is observed in both developed and developing countries. Mexico, Ghana, Philippines and Sri Lanka are some of the developing countries that show males being more involved in pedestrian road traffic fatalities (WHO, 2013; Damsere-Derry et al., 2009; Verzosa & Miles, 2016; Edirisinghe, Kitulwatte & Senarathne, 2014). Studies in developed countries such as the United States of America (USA), France and Finland also found males to be more involved in road traffic crashes (WHO, 2013; Martin, Lardy & Laumon, 2011; Malin, Silla & Mladenovic, 2020). This higher trend in

males across the globe suggests the likelihood of males having more impulsive behaviour than females (Martin et al., 2011).

Pedestrian road traffic crashes affect different age groups, although some age groups may be more prevalent than others (WHO, 2013). Literature shows that pedestrian deaths are more prevalent in older adults aged 60 years or 65 years and above (Verzosa & Miles, 2016; Edirisinghe et al., 2014; Martin et al., 2011; Martinez-Ruiz et al., 2019). The elderly are amongst the high-risk group as they have slow reaction time and reduced sensory inputs (Chong et al., 2018). These studies represented both developing and developed countries.

However, in South Africa, the majority of the pedestrian fatalities are between 30-34 years of age as opposed to the elderly in most countries (RTMC, 2018). The Western Cape Injury Mortality Profile (WCIMP), however, reported a high pedestrian mortality rate of male children under the age of 5 years in the Western Cape (WCIMP, 2018). Children tend to play on the road when unsupervised and are unable to correctly observe the speed of the oncoming cars (WHO 2013). The RTMC (2018) identifies jay-walking as a contributory factor of the high pedestrian fatalities. This does not isolate a specific age group in the report, but applied to overall pedestrian road traffic fatalities.

- Influence of drugs and alcohol

Alcohol and drugs play a role in pedestrian fatalities (Verzosa & Miles, 2016) and with predominance of alcohol as a problem in several countries like the United Kingdom (UK) and USA (WHO, 2013). Studies in Georgia reveal traces of both alcohol and drugs in samples of pedestrians. The drug screen shows presence of prescription drugs (opioids and benzodiazepines), cocaine or cocaine metabolites and marijuana (Thomas & Jones, 2018). Studies in Jordan, a country in Southwest Asia also show pedestrian results with positive alcohol and psychotropic drugs (barbiturates and benzodiazepines), however, with no traces of cocaine, amphetamines and cannabis (Al-Abdallat, Al Ali, Hudaib,

Salameh & Salameh, 2016). Both studies do not elaborate on the drug levels. However, the dangers of psychotropic drugs are that they impair judgement, normal reflexes and intellectual function (Al-Abdallat et al., 2016).

du Plessis, Hlaise and Blumenthal (2016) did a study looking at ethanol levels in relation to road traffic fatalities. The study done at a hospital in a South African township show that pedestrians were the second most prevalent group with high blood alcohol. The study further highlighted that within the group of pedestrian fatalities, males have a higher blood alcohol level as opposed to females. The WCIMP (2018) reports that alcohol is associated with 60% of pedestrian fatalities in the Western Cape Province of South Africa. The danger of intoxicated pedestrians is that they are more likely to enter roads at risky locations and at dangerous moments due to impairment of cognitive function (Dultz, Frangos, Foltin, Marr & Simon, 2011). The researcher will, however, not include alcohol and drugs as a contributory factor, as retrieving all the results may be a limiting factor due to the backlog at the Pretoria Forensic Chemistry Laboratory.

- Type of clothing

The type of clothing worn may assist with visibility, particularly at night (Pour-Rouholamin & Zhou, 2016). The risk of fatality is lower in pedestrians wearing reflectors or reflective clothing as that improves their visibility at night (Martinez-Ruiz et al., 2019). Those not wearing reflective clothing or brightly coloured clothes are at risk of pedestrian crashes and fatalities at night or at dawn (WHO, 2013).

Driver factors

Speed is one of the risk factors in the probability of pedestrian road traffic crashes and injury severity (Jurewicz, Sobhani, Woolley, Dutschke & Corben, 2016; Hussain et al., 2019; WHO, 2013). Drivers leading to pedestrian fatalities

do not always adhere to speed limits. Often drivers fail to yield at marked pedestrian crossings resulting in pedestrian road traffic crashes (WHO, 2013). The risk of pedestrian crashes is also higher in those drivers that are incapacitated (Verzosa & Miles, 2016). Alcohol impairs visual acuity, judgement and results in less vigilant drivers (WHO, 2013) who may also be speeding. The drivers may also have fatigue or be distracted in the car resulting in pedestrian road traffic crashes (WHO, 2013).

Environmental factors

Timing

One of the greatest risk factors of pedestrians is travelling at night (WHO, 2013). Studies show that pedestrian fatalities are common in the afternoon and night time in most states in the USA, Finland and Spain (Malin et al., 2020; Martinez-Ruiz et al., 2019; Pour-Rouholamin & Zhou, 2016; Thomas & Jones, 2018; WHO, 2013). A similar trend is seen in Ghana and Philippines (Damsere-Derry et al., 2010; Verzosa & Miles, 2016), where pedestrian injuries and fatalities are more at night time than daytime. This highlighted that most pedestrian fatalities occur in the afternoon or evening in both developed and developing countries.

The WHO (2013) notes that pedestrian collisions occur during the week, while fatal pedestrian collisions occur on weekends. In the USA, pedestrian fatalities happen on weekdays in December, and Fridays and Saturdays in June (WHO, 2013). Pedestrian fatalities are higher on Fridays in Ghana (Damsere-Derry et al., 2010).

The RTMC statistics reveal that more road traffic crashes occur in the late afternoon and evening (2018) and happen mostly on Fridays, Saturdays and Sundays (2018). The report does not highlight timing of pedestrian fatalities but rather of road traffic crashes. The WCIMP in South Africa show that pedestrian

fatalities occur more frequently on Friday and Saturday in the afternoon and evening, and between midday to afternoon throughout the week in the Western Cape Province (2018). This trend is seen among children less than 15 years. In the age group above 15 years, pedestrian fatalities are frequent in the evening to early hours of the morning (9pm-4am) on Fridays, Saturdays and Sundays. In Mpumalanga and Gauteng Province of South Africa, transport related deaths occur mostly in the afternoon and the evening (NIMSS, 2013; NIMSS, 2013) and on Fridays, Saturdays and Sundays (NIMSS, 2013; NIMSS, 2013). Both reports did not elaborate on timing of pedestrian deaths but rather of transport related deaths as a whole.

The higher incidence of pedestrian deaths in the afternoon and evening may be associated with darkness and poor visibility. Dark conditions reduce pedestrian visibility, making it more difficult for the drivers to see the pedestrians (Mian & Caird, 2018). Reasons are not provided for these weekend trends of pedestrian fatalities, however, it may be due to people travelling and socializing more over the weekends as opposed to weekdays.

Seasonal trends are highlighted as contributory factors in pedestrian fatalities. Malin et al. (2020) studied pedestrian fatalities in Finland and notes the fatalities to occur mostly in winter (December-February) and the least fatalities in summer (June-August). Seasonal trends in South Africa show that pedestrian deaths are distributed throughout the year with peak months in June (winter) and September (spring) (Mabunda, Swart & Seedat, 2008). The National Injury Mortality Surveillance System (NIMMS) show that transport related deaths in Gauteng peak in September (NIMMS, 2013) and in September (spring) and December (summer) in Mpumalanga Province. The writers did not elaborate reasons for this trend, however during winter there is reduced visibility and misty weather. In South Africa, the researcher observed a tradition of many celebrations to welcome the spring season and festive season in December and most celebrations involve alcohol consumption by both drivers and pedestrians.

Weather conditions

Inclement weather is found to have lower probability of fatalities in the Philippines (Verzosa & Miles, 2016). This is stated to be due to the drivers being more cautious and adjusting to road conditions (Verzosa & Miles, 2016). There were also less pedestrian fatalities in wet road conditions (Malin et al., 2020). Pour- Rouholamin and Zhou (2016) state that in addition to drivers being more cautious, pedestrian activity is lower during such conditions in Illinois. However, a study in Hong Kong found that the risk of pedestrian fatalities and severe injuries is higher during rainy weather (Zhai, Huang, Sze, Song & Hon, 2019). This is attributed to both drivers and pedestrians being impatient during such weather and reduced visibility on the road (Zhai et al., 2019). The RTCM (2018) in South Africa reports wet/ slippery road surface contributing to 12.6% of total road crashes; however, the report did not clarify if any of those crashes involved pedestrian fatalities.

Road conditions

Roadway design generally caters for the needs of motorized traffic than that of pedestrians (Mokoma, 2017), thereby increasing the risk of injury and fatalities of pedestrians (WHO, 2013). Roads with multi-lanes are associated with the likely hood of pedestrian fatalities, as those roads enable higher speeds than the permitted limit (Verzosa & Miles, 2016). Damsere-Derry et al. (2010) note that pedestrian fatalities are higher at road sections without traffic medians. Traffic medians separate opposing traffic streams, thereby assisting pedestrians to cross the roads in stages (Damsere-Derry et al., 2010).

Darkness on unlit roads is a common factor in pedestrian fatalities (Wang & Cicchino, 2020). More lighting on the roads improves pedestrian visibility, thus enabling drivers to react in time to pedestrians (Wanvik, 2009; Wang & Cicchino, 2020). The burden of unlit roads may be worsened on roads with surrounding settlement areas (Damsere-Derry et al., 2010). Studies show that

crashes are higher in localities with mixed residential and commercial land use, as there is more pedestrian activity (Wang & Cicchino, 2020). This can be catastrophic if in addition to these factors, there are alcohol outlets within those residential areas close to the road (DiMaggio, Mooney, Frangos & Wall, 2016).

Mokoma studied pedestrian fatalities on the R71 road in Limpopo Province (South Africa). The study found that road factors are highlighted as one of the contributory factors of fatalities. The study, however focuses on two sections on the R71 road, which are areas around Dalmada and Myngenoegen, as well as R71 road between Nobody and Moria. The R71 road is classified as a Class R2 Major Arterial Road, which is mainly a mobility road (Mokoma, 2017). A mobility road is characterized by higher traffic volume and higher travel speeds with limited access (COTO, 2012). Drivers do not always adhere to speed limits, and thus introducing speed reducing measures like speed cameras and more police visibility should be implemented on the roads (Hussain et al., 2019).

2.3 INJURIES BY REGION

Pedestrians sustain injuries that are complex and may affect the entire body (Aquila, Nunzio, Paciello, Britti & Pepe, 2014). The pattern of injuries and outcomes may differ according to point of impact, speed of vehicle and the type of car. Furthermore, the severity of injuries on various body regions can assist with the direction of the primary impact (Burke, 2007). Primary injuries come because of the victim's first impact with the vehicle. Subsequent contact with the vehicle leads to secondary injuries (Reddy & Murty, 2014). Upon impact with the ground, they sustain tertiary injuries (Saukko & Knight, 2016). Documentation of the location, extent and nature of the injuries assist to establish the injury pattern (Reddy & Murty, 2014).

It is known that crash impact speed influences injury severity and death of pedestrians (Teft, 2013). In high-speed impact, which Saukko and Knight (2016) state as anything over 50 km/h, the body may sustain both primary and

secondary injuries. This comes because of the body being flung high in the air and thereafter the body landing on either to the side or in the path of the car (Saukko & Knight, 2016). The body may also land backwards over the roof. In this case, both primary and secondary injuries will be present and more severe. Low speeds (below 15-20mph, which is equivalent to 24.5km/h-32km/h) are associated with less injuries and death, with risks increasing with increment of speed (Teft, 2013). The risk of pedestrian fatalities increases with impact speeds between 30-70km/h (Hussain et al., 2019). In addition to impact speed, literature also highlights the role of different car types in injury patterns sustained by pedestrians. When a light motor vehicle with a defined hood strikes an upright pedestrian, the point of impact will be at the lower limbs, mostly at the level of the knees. This results in the body being scooped upwards, hitting the hood and windshield or alternatively be vaulted over the cabin, if the same car is speeding (Bogert, Salomone, Goslar & Weinberg, 2019; Burke, 2012). This may result in lower extremities injuries, followed by pelvis, head and neck injuries (Bogert et al., 2019; Burke, 2012).

Larger passenger vehicles, sports utility vehicles (SUV), vans, buses and trucks are associated with greater injury severity of pedestrians (Pour-Rouholamin & Zhou, 2016; Martinez-Ruiz et al., 2019). They have a greater mass, higher bumpers and blunt frontal profile, resulting in the victim being thrown forward onto the road (Bogert et al., 2019). The initial impact is usually above the knees with primary injuries to the pelvis, abdomen, shoulder girdle, arm or head (Saukko & Knight, 2016). It is known that the point of impact, the speed of vehicle and position of the individual at the time of impact are better determinants of injury severity than the design of the front of the car (Martin et al., 2011). The researcher will outline the various types of injuries sustained by pedestrians in road traffic crash fatalities. These will include external, visceral, and skeletal injuries.

Body Surface injuries

These are external injuries sustained on the surface of the body .The injuries range from minor abrasions and bruises to ragged lacerations and degloving wounds. These body surface injuries may be found anywhere on the body. In run-over pedestrians, grease marks, patterned abrasions or intradermal bruise from contact with the tyre may be seen (Burke, 2007), while brush abrasions are on the opposite side of the body (Reddy & Murty, 2014). In addition, avulsion injuries involving the arm or leg are also present in run over pedestrians (Reddy & Murty, 2014). Such injuries are not limited to limbs and involve the abdomen, leading to extruded intestines and testes (Reddy & Murty, 2014). From a medico legal point of view, the tyre profile marks may assist in identification of the car (Edirisinghe et al., 2014) although this may be a challenge if there is involvement of more than one car. Other parts of the car such as the headlamp can leave imprint abrasions on the skin (Saukko & Knight, 2016) which may also assist with identification of the involved car

Head and facial injuries

Head injuries are among the most frequent injuries found in pedestrian road traffic fatalities (Zivkovic, Nikolic, Strajina, Djonic & Babic, 2012). This is also the most common injury in children involved in pedestrian road traffic fatalities (du Toit-Prinsloo & Saymaan, 2014).

Depending on the impact with the windshield of the car or the surrounding, they can sustain abrasions, lacerations and incised injuries on the head (Burke, 2007). Skull fractures may or may not be present .The common skull fracture in road traffic fatalities is the hinge fracture on the base of skull (Saukko & Knight, 2014). Some studies show brainstem lacerations to be associated with hinge or ring fractures (Zivkovic et al., 2012). In run over pedestrians, the skull may be crushed and with the brain extruded and pulpified (Payne-James, Jones, Karch & Manlove, 2011).

Brain injuries may vary due to blunt force injuries and rotational acceleration of the head (Burke, 2007). This leads to focal or diffuse injuries, which include mostly hematomas, contusions, intracranial haemorrhage and diffuse axonal injuries (Li, Wang, Otte & Simms, 2019).

Cervical spine injuries

Upper cervical injuries and atlanto-occipital fractures/ dislocation are common injuries (Burke, 2007). Severe whiplash injuries may be associated with overstretching in the front of the neck. These types of injuries are seen in pedestrians struck by a speeding car from behind (Spitz & Fisher, 2006; Reddy & Murty, 2014).

Spitz and Fisher (2006) report fractures of the cervical spine, which are associated with rear impact of pedestrians. The spine may also dislocate at the base resulting in atlanto–occipital dislocation. Run over pedestrians may have decapitations and crushed vertebral column (Spitz & Fisher, 2006).

Thoracic cage, visceral thoracic injuries and thoracic spine injuries

The ribs, sternum and thoracic spine may fracture. Flail chest may result from compression of the chest (Payne-James et al., 2011). The lung and heart may sustain contusions or laceration from either the rib cage or direct impact of the car. Rupture of aorta may be seen in higher speeds (Burke, 2007).

Abdominal injuries and lumber spine injuries

Injuries depend on the impact and vehicular speed. They may sustain ruptured internal organs, perforated intestine, lacerated mesentery and fractured lumbar spine (Saukko & Knight, 2016). The kidneys may rupture in posterior impact (Burke, 2007).

Pelvic injuries

Pelvic injuries vary from separation of the pubic symphysis to open book fractures. The pelvis may flatten or the symphysis or superior rami fracture in run-over accidents (Saukko & Knight, 2016). The sacro-iliac joint may also be dislocated. Spitz and Fisher (2006) report fractures of the pubic ramus from impact with the front fender of the car.

Upper and Lower extremities injuries

Lower limb injuries are frequent in pedestrians (Aquila et al., 2014) in relation to the upper limbs injuries. The upper limb injuries range from non-specific abrasions and soft tissue injuries to fractures. Direct trauma to the arm and forearm results in transverse fractures of the long bones (Burke, 2007).

The pedestrians may have abrasions and lacerations to the upper shin and knee, which may signify contact with the car bumper (Saukko & Knight, 2016). Caution must be applied, as the point of impact by the bumper on the lower limbs may not always correlate with the height of the car bumper in cases where the driver has applied brakes or individuals with high sole shoes. Bumper injuries at different levels on each leg may indicate that the individual may have been walking or running (Saukko & Knight, 2016; Spitz & Fisher, 2006). The bumper injuries also include injuries to the soft tissues and fractures of the tibia, fibula and femur bone (Spitz & Fisher, 2006). The tibia may show a spiral or wedge shaped fracture whereby the base of the wedge is usually the point of impact whilst the apex points in the direction that the vehicle is travelling in (Reddy & Murty, 2014). Some of the pedestrians sustain complex fractures and traumatic amputations upon being thrown up in the air at higher speeds (Payne-James et al., 2011). In addition to amputations of limbs, the torso may transect following high-speed impact on the highway (Burke, 2007).

In conclusion, literature review highlighted commonly encountered pedestrian injuries and the mechanisms involved. It further highlighted those injuries that may be associated with high impact speed such as severe whiplash injuries, rupture of the aorta, complex lower limb fractures, traumatic amputations, and transected torso. In addition to speed, there were other contributory factors associated with pedestrian fatalities (human factor and environmental factors). However, there is not much literature highlighting these contributory factors in our local setting

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter discusses the research methodology that was used in the study. The research design, study setting, the study population and sample size, the data collection tool, and how data will be collected and analysed. Validity, reliability, and ethical considerations, shall also be discussed.

3.2 RESEARCH DESIGN

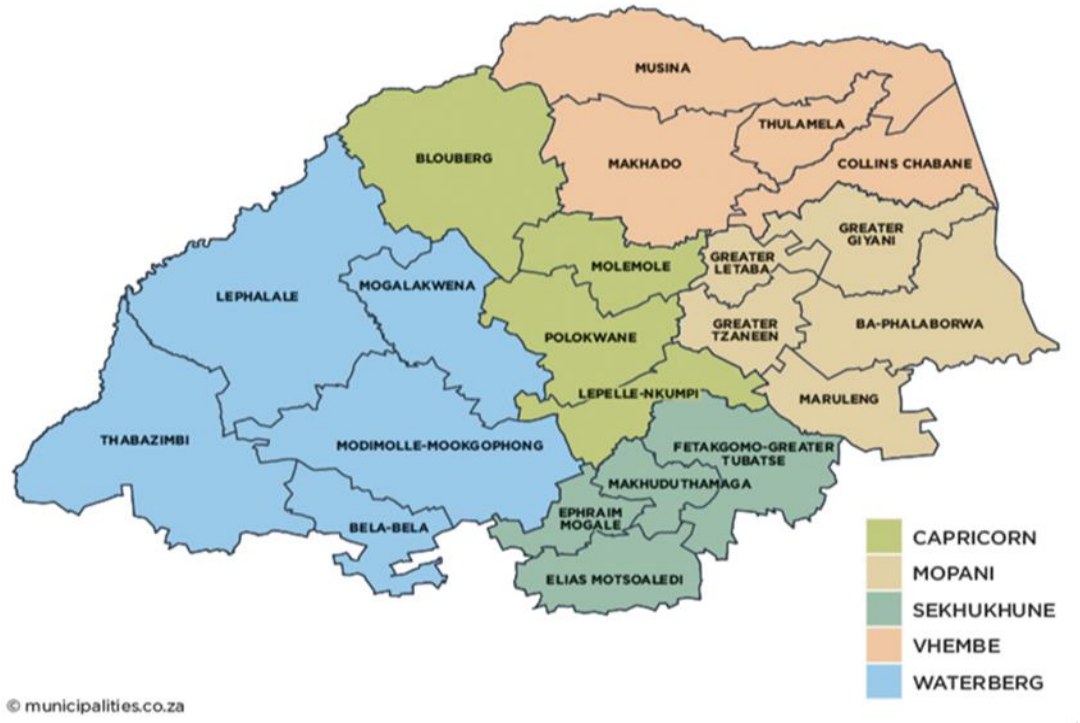
A quantitative descriptive study was used in describing variables, thereby answering the research questions (Brink, van der Walt & van Rensburg, 2012). A retrospective descriptive study was conducted on pedestrian cases that demised because of R71 road traffic crashes. The researcher described the characteristics of the study population using existing data. This comprised of demographics (age and gender), clothing worn, locality of the crashes, environmental factors and types of injuries associated with the pedestrian fatalities and determining presence of contributory factors to those fatalities.

3.3 STUDY SETTING

The study was conducted on cases of pedestrians that demised because of the R71 road traffic crashes and admitted at Polokwane Forensic Pathology Services (PFPS) located in the Pietersburg Provincial Hospital grounds. The PFPS admits cases from the Capricorn district of Limpopo Province (Figure 3.1) for medico-legal autopsies. These include cases that demised at the scene (R71 road) and those that demised at the hospital.

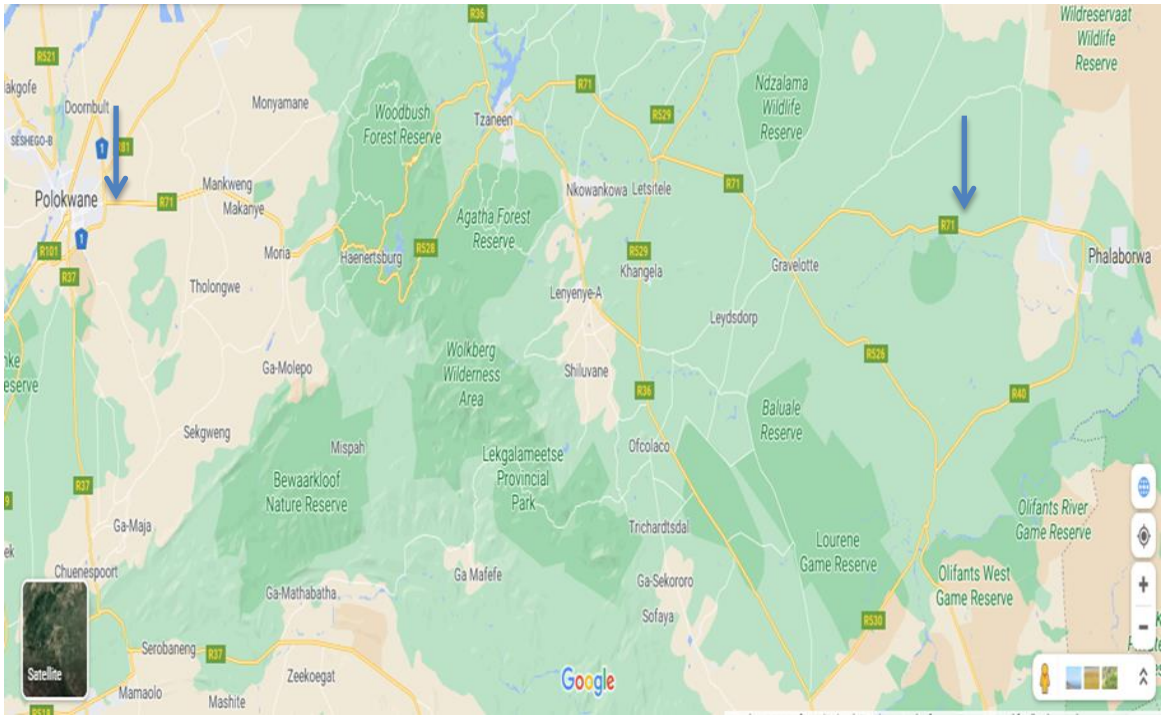
R71 road (figure 3.2) is a provincial route connecting Polokwane town with Kruger National Park via the major town of Tzaneen and Phalaborwa (Falkner,

2012). The road is both a single carriageway and dual carriageway. Within the study area, the road is mostly dual carriageway associated with high speeds (Mokoma, 2017). The study area was from Polokwane until Haenertsburg, consisting of cases that are admitted in PFPS. This covered Capricorn and Mopani districts within Limpopo Province (Figure 3.1). R71 road starts at the N1 bypass in Polokwane and continues through Dalmada and Myngenoegen, then through several villages along the road before proceeding to Haenertsburg. There are residential areas, schools, a mall and bottle stores close to the road.



https://municipalities.co.za/img/provinces/limpopo_municipalities_map.png

Figure 3.1 Limpopo Province with the different districts



https://www.google.com/maps/

Figure 3.2 R71 road

3.4 STUDY POPULATION AND SAMPLING

3.4.1 Study population

Study population is defined as the entire group of persons or subjects that is of interest to the researcher (Brink et al., 2012). This is the group the researcher sampled (Trochim, Donnelly & Arora, 2016). The study population were cases of pedestrian fatalities that demised as a result of R71 road traffic crashes and admitted at PFPS.

3.4.2 Sample size and technique

From the study population, a selected group or elements were selected to form a sample (Brink et al., 2012; Jacobsen, 2017). To achieve this, the researcher used total population purposive sampling of cases admitted at Polokwane FPS between 1 January 2017 and 31 December 2019. Thus, no calculation was required to establish the sample size. A total of 65 cases of pedestrian road

traffic fatalities that were admitted at PFPS during the study period were studied.

Inclusion criteria

- All cases of pedestrian fatalities that were admitted at PFPS between 1 January 2017 to 31 December 2019, regardless of the date of the accident. The date of admission at PFPS was the determining date since the date of the accident may fall outside the study time frame.

- Pedestrians that succumbed to injuries at the scene and at the hospital. This allowed the researcher to have a more representative and inclusive sample.

Exclusion criteria

- Cases of pedestrian fatalities that demised as a result of R71 road traffic crashes but succumbed to injuries in other provinces. The reason for exclusion of such cases was that those were not admitted at PFPS and secondly it may be difficult to retrieve data from other provinces.

- Cases of pedestrian fatalities admitted to PFPS outside the study period.

- The cases with missing hospital records were excluded from the study.

3.5 DATA COLLECTION AND STUDY TOOL

The study utilized secondary data obtained from the Forensic Pathology Service dockets. The researcher retrieved dockets and used the SAP 180 forms, scene forms, post mortem reports and DHA-1663. The SAP 180 form is a document completed by the SAPS prior to cases being admitted in Polokwane FPS. The form detailed circumstances of injury (e.g. pedestrian), place of injury (locality),

date and time of injury and place of death. This information was also retrieved from the scene form. The post mortem report is the formal document that details the injuries sustained. The DHA-1663 form assisted with demographics (age and gender) of the deceased as provided by the next of kin. The hospital files were also retrieved in order to ascertain that the deceased were involved in a pedestrian road traffic crash along the R71 road and not any other road. Secondly, the hospital records assisted in injuries of those pedestrians that demised at the hospital, particularly those that had prolonged hospital stay, as those injuries were not apparent at autopsy due to healing processes. However not all hospital records could be retrieved.

The researcher also communicated with the South African Weather Service (Climate Section) in order to access the weather patterns (presence of rain, mist/fog, sunny weather and clear weather) of the specific days of the pedestrian road traffic crashes. Communication via email was made with the climate section and a disclosure form was completed. The South African Weather Service then emailed the available data. The data was incomplete for certain weather elements as Polokwane is the only weather station with personnel while Mankweng and Haenertsburg have none (Annexure E). The rain coverage for Mankweng weather was only available from mid-2018, as Mankweng station only became operational in 2018. Therefore, the data could not be used, as it was incomplete.

The collected data was then documented on a data collection tool that was generated by the researcher. The contents of the data collection tool were guided by literature review. The data collection tool detailed pedestrian factors (demographics namely age and gender), the type of clothing that was worn, environmental factors (timing of the pedestrian road traffic crashes), locality of crashes and pattern of injuries sustained by the pedestrians (see Annexure A). The initial data collection tool was revised due to unavailability of the weather elements and as advised by the statistician.

3.6 DATA ANALYSIS

Data was collected, captured and analysed using Statistical Software for the Social Sciences (SPSS) version 26.0. The variables were documented in graphs, pie charts, tables and the analysed variables presented as percentages. The continuous variables will be expressed as mean +/- SD.

3.7 RELIABILITY AND VALIDITY OF THE STUDY

Reliability demonstrates consistency, stability and repeatability as well as accurate collection and recording of information by the researcher (Brink et al 2012). The researcher did a pilot study prior to the actual data collection in order to scrutinize the data collection tool and modify it accordingly. Modifications were made after consultation with the supervisor and co-supervisor.

For the study to be valid, there must be meaningful and credible results or scientific findings (Leedy & Ormrod, 2015). To ensure internal validity, the researcher discussed the contents of the data collection tool with the supervisor and biostatistician to assess whether the tool will give the actual and truthful results.

3.8 BIAS

Bias is an influence that can results in errors affecting the quality of the study, and can occur at any stage of the research process (Brink et al., 2012).

Sampling Bias

The researcher minimized sampling bias by using consecutive sampling of all cases in order to have a more representative sample size (Brink et al., 2012).

Unavoidable bias

Some records were missing or poorly documented, as this is a retrospective study. The cases with missing records were excluded from the study. There were those cases with poorly documented information. As such on the data collection tool, there were specific parameters that had a category of “unspecified”, which covered some of the poorly documented data.

Information Bias

Information bias can result in overrepresentation or underrepresentation of described variables (Joubert & Ehrlich, 2007). Information on clothing worn by the pedestrians was only available for pedestrians that demised at the scene and not at the hospital.

3.9 ETHICAL CONSIDERATIONS

3.9.1 Ethical clearance

Ethical clearance (Annexure B) was requested and granted by the Turfloop Research Ethical Committee as well as Polokwane Mankweng Research Ethical Committee (Annexure D). Permission was also obtained from the Limpopo Provincial Department of Health to conduct the study (see Annexure C).

3.9.2 Right to privacy/confidentiality

Privacy in the research study should be maintained through provision of anonymity (Trochim et al., 2016) .The researcher ensured anonymity by using post mortem numbers only during data collection but did not include them in the data reporting and data analysis. This ensured that personal identity of the deceased remained anonymous.

Trochim et al. (2016) define confidentiality as “the researcher making a promise not to share any identifying information about the deceased to anyone outside the study”. The researcher ensured this by storing the collected information in a locked office at PFPS and utilized a computer with a password in place to ensure that there is no unauthorized access to the collected information. The data gathered was only accessible to the researcher and supervisor.

3.9.3 Non-maleficence & Beneficence

The principle of non-maleficence was maintained by ensuring that the reporting of study findings is done in a way that will be sensitive to the families of the deceased (Brink et al., 2012) as data used will be anonymised.

3.9.4 Respect and Dignity

The researcher used secondary data of pedestrians that demised on the R71 road. The researcher ensured that the data collected was handled with respect and dignity by maintaining anonymity at all times.

3.9.5 Avoidance of Harm

The researcher did not include the names of the deceased in the data collection tool or anywhere else in the research document. The researcher maintained anonymity by using post mortem numbers only during data collection but did not include them in the data reporting and data analysis. This ensured that personal identity of the deceased remained anonymous. By so doing this minimised harm to the surviving relatives.

CHAPTER 4

PRESENTATION AND INTERPRETATION OF FINDINGS

4.1 INTRODUCTION

The study profiled pedestrian road traffic crash fatalities on the R71 road, which were admitted at Polokwane Forensic Pathology Services. Contributory factors of these fatalities were investigated, as well as the type of injuries sustained. This chapter will present and interpret the results.

4.2 DATA ANALYSIS AND FINDINGS

Contributory factors that were studied included pedestrian factors, namely demographics (age and gender) and the type of clothing that was worn. The study also looked at environmental factors (timing of these fatalities) and locality of the pedestrian road traffic fatalities.

4.2.1 Pedestrian factors

Demographics (Age and gender)

In the study (figure 4.1), majority of pedestrian road traffic fatalities involved adults between the ages of 20-39 years (48%), followed by those aged between 40-49 years old (17%), and lastly followed by the elderly aged above the age of 60 years (12 %).

Males were noted to have a higher percentage (77%), as opposed to their female counterparts that contributed 23% of overall deaths (figure 4.2).

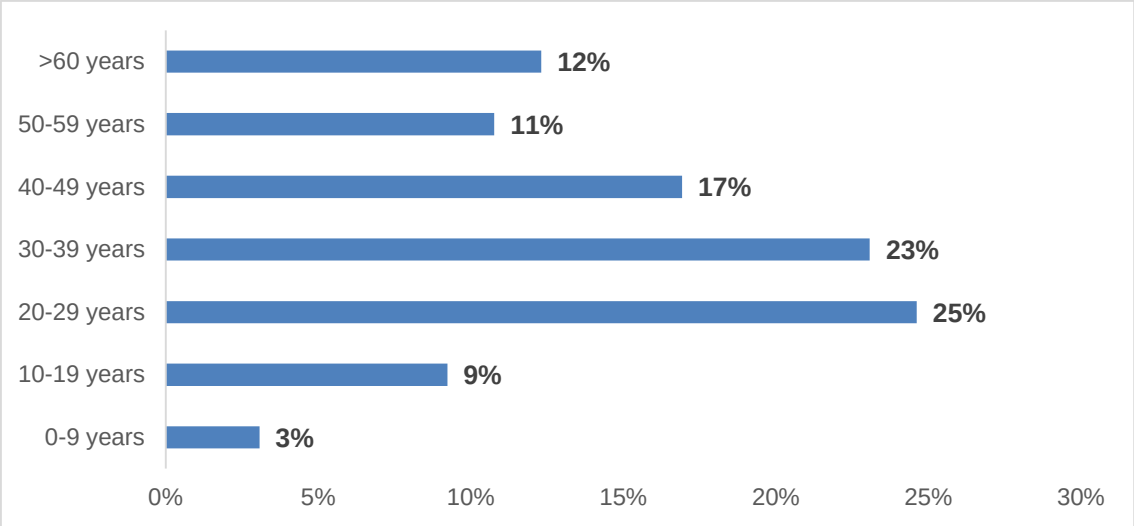


Figure 4.1 Ages of the pedestrians

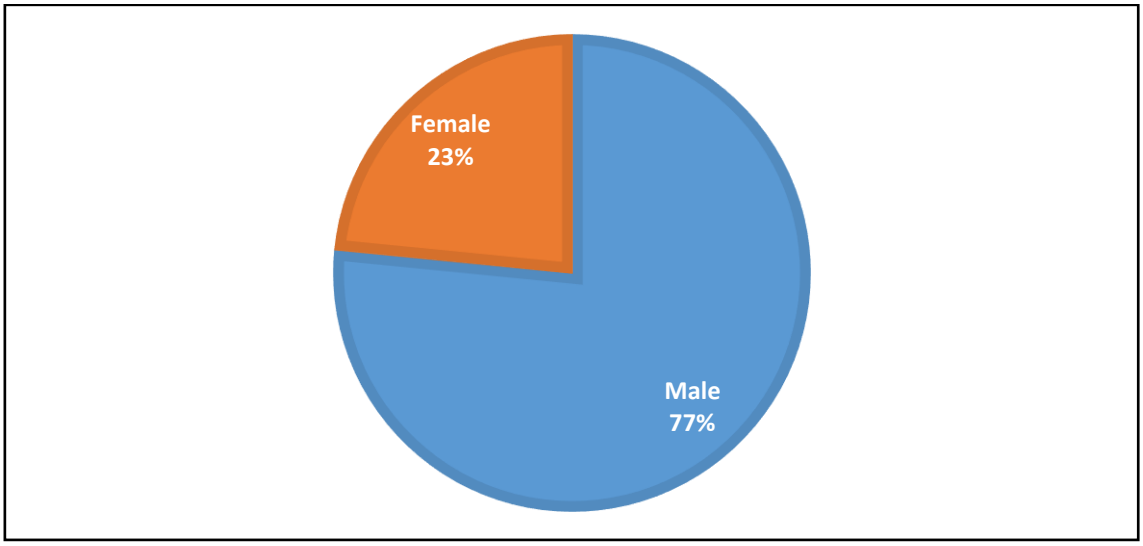


Figure 4.2 Pedestrian fatalities by gender

Clothing

Majority of the pedestrians (58%) either wore dark colours with no reflector on, whilst only 14% wore bright coloured clothing or had a reflector on (figure 4.3). 28% of the total number of studied cases were classified as unspecified. This category included those pedestrians whose clothes were not described in the

post mortem reports and it included the pedestrians that demised after being admitted in hospital.

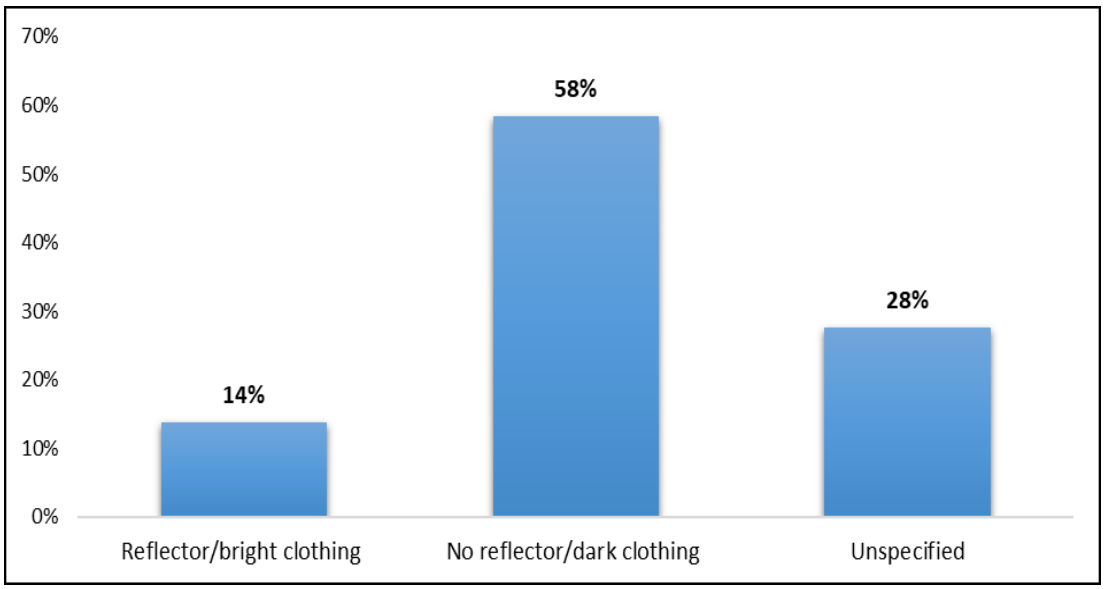


Figure 4.3 Clothing worn by pedestrians

4.2.2 Environmental factors:

Timing

Pedestrian road traffic fatalities occurred throughout the week (figure 4.4), with majority of cases occurring from Friday to Sunday (72%). A total of 51% of the fatalities occurred between 18:00 to 23:59 (figure 4.5), which was followed by fatalities occurring between 00:00-00:59 (23%). The least pedestrian fatalities were seen between 06:00-11:59 (14%) and between 12:00-17:59 (12%).

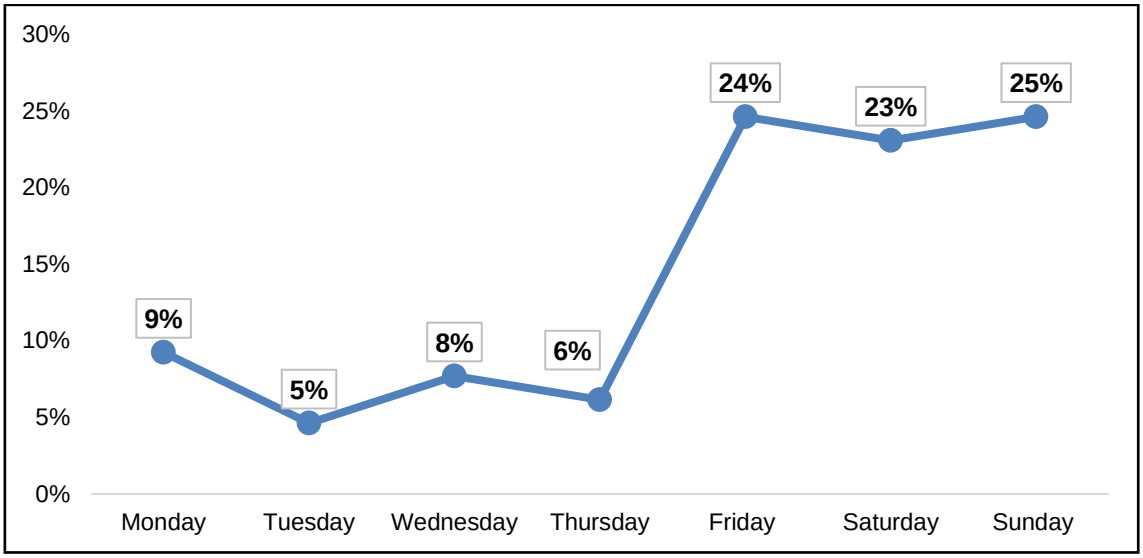


Figure 4.4 Peak days of deaths

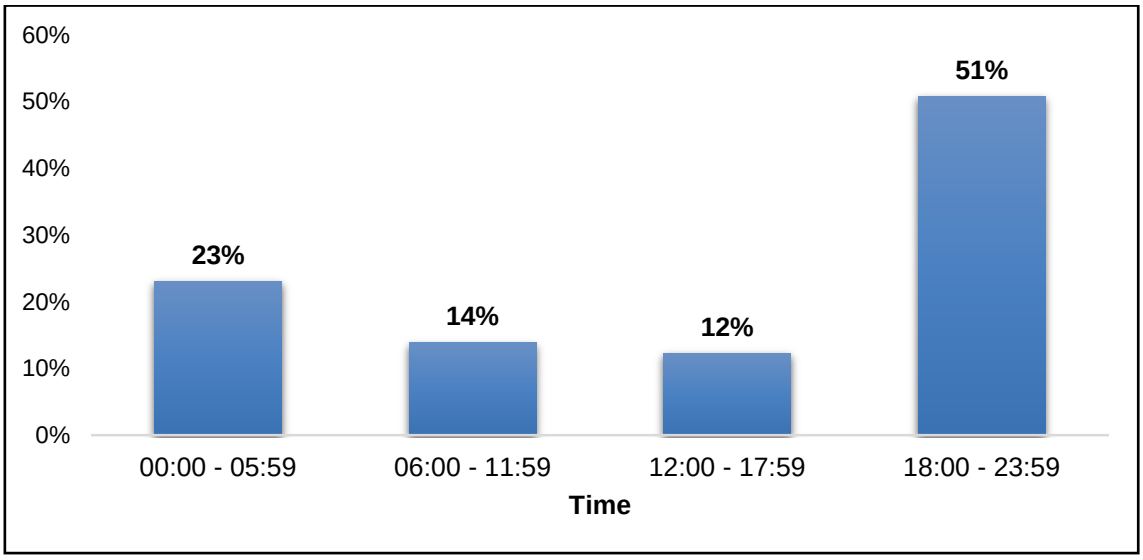


Figure 4.5 Time of pedestrian fatalities

Although pedestrian road traffic fatalities occurred throughout the year (figure 4.6), the peak months were noted to be December (14 %), followed by February (12%), June (11%) and September (11%). The peak season (figure 4.7) was in summer (December, January, February), followed by autumn (March, April, May) with equal distribution seen in Spring (September, October, November) and Winter (June, July & August).

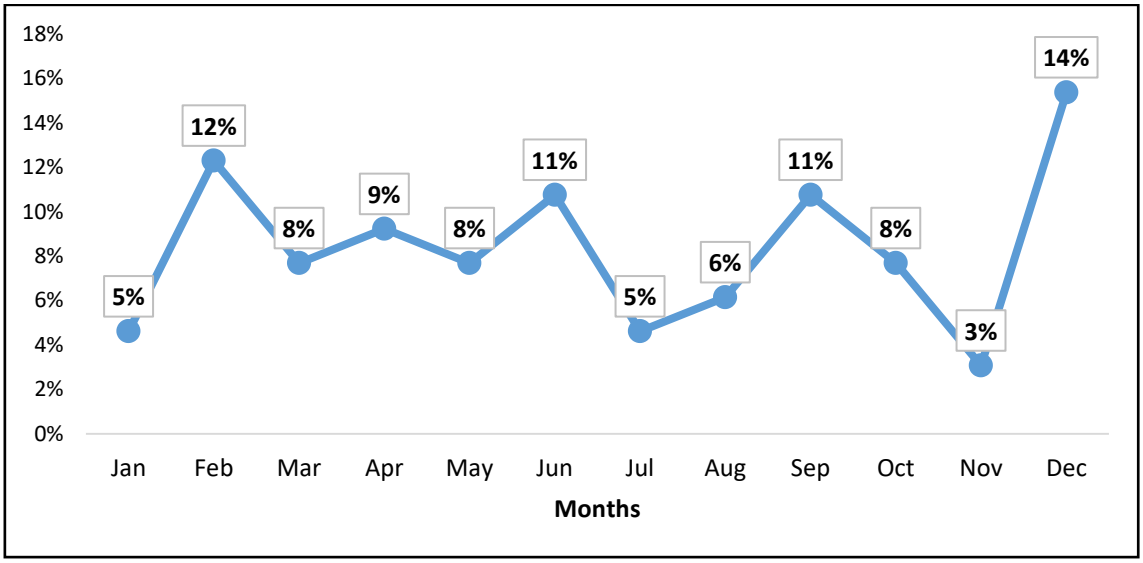


Figure 4.6 Pedestrian fatalities per month

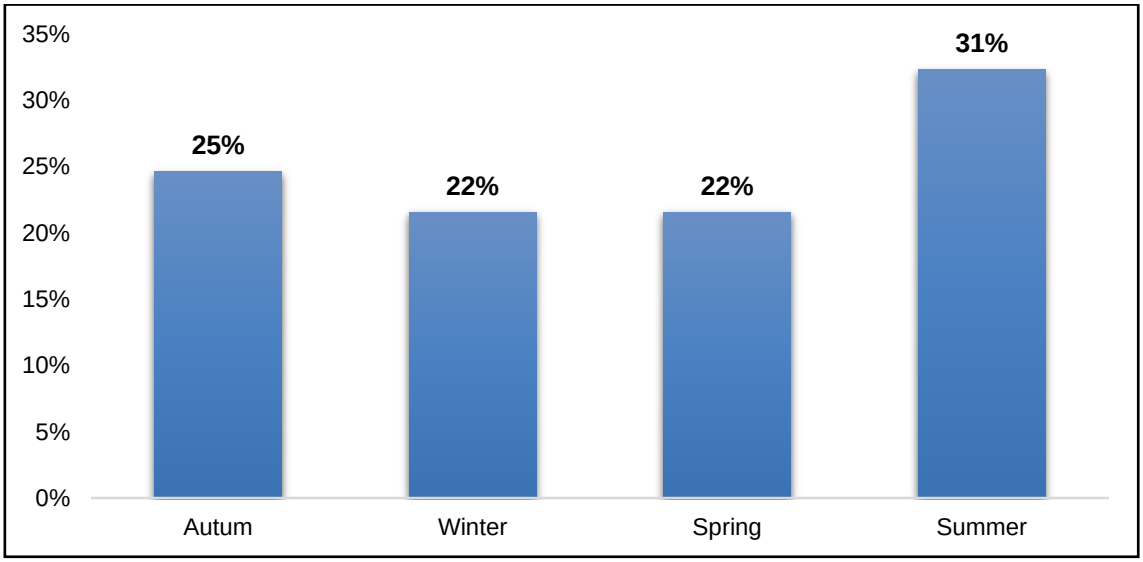


Figure 4.7 Pedestrian fatalities per season

Locality

The R71 road was divided into Area 1 to Area 5 (figure 4.8). Area 6 covered those cases whereby the exact location was not specified along the R71 road. Majority of the pedestrian road traffic fatalities were seen in Area 3 (43%), which covers Mankweng, Paledi mall area up to Mentz village. This was followed by Area 2, which covered Nobody village to Mamadimo and Moremadi Park. Least

cases were seen in Area 4 (6%), which covers Boyne/Moria area and Vikings village.

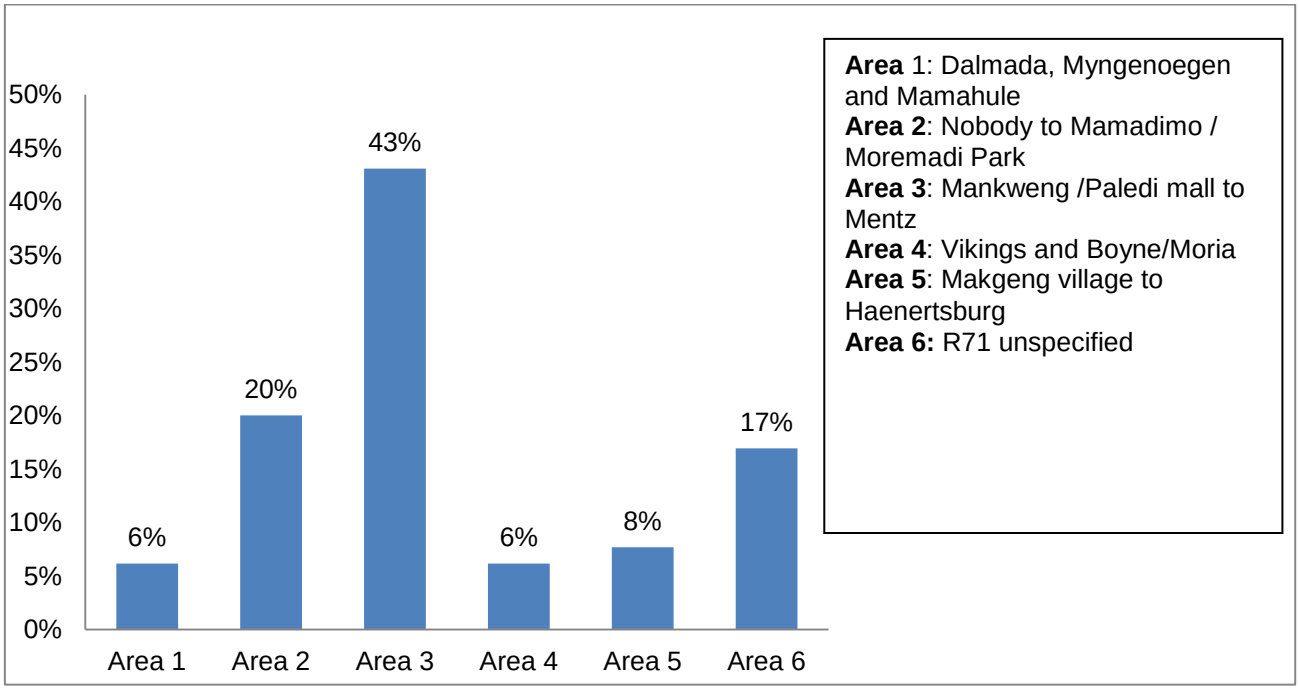


Figure 4.8 Locality of the pedestrian fatalities

4.2.3 Injuries sustained by the pedestrians

The study outlined the injuries sustained by the pedestrians. Pedestrians may sustain body surface injuries, which may be focal or on multifocal areas of the body. These injuries range from lacerations, abrasions bruises, incised wounds. In the study, most pedestrians who sustained surface injuries (figure 4.9) had abrasions and these were mostly seen on the lower limbs (55%) followed by those seen on the head (53%). This could be associated with the bumper injuries on initial contact with the vehicle. There were fewer bruises and incised wounds noted on the body. On the contrary, surface injuries (in particular abrasions, lacerations and bruises) on the abdomen and upper limbs were relatively uncommon.

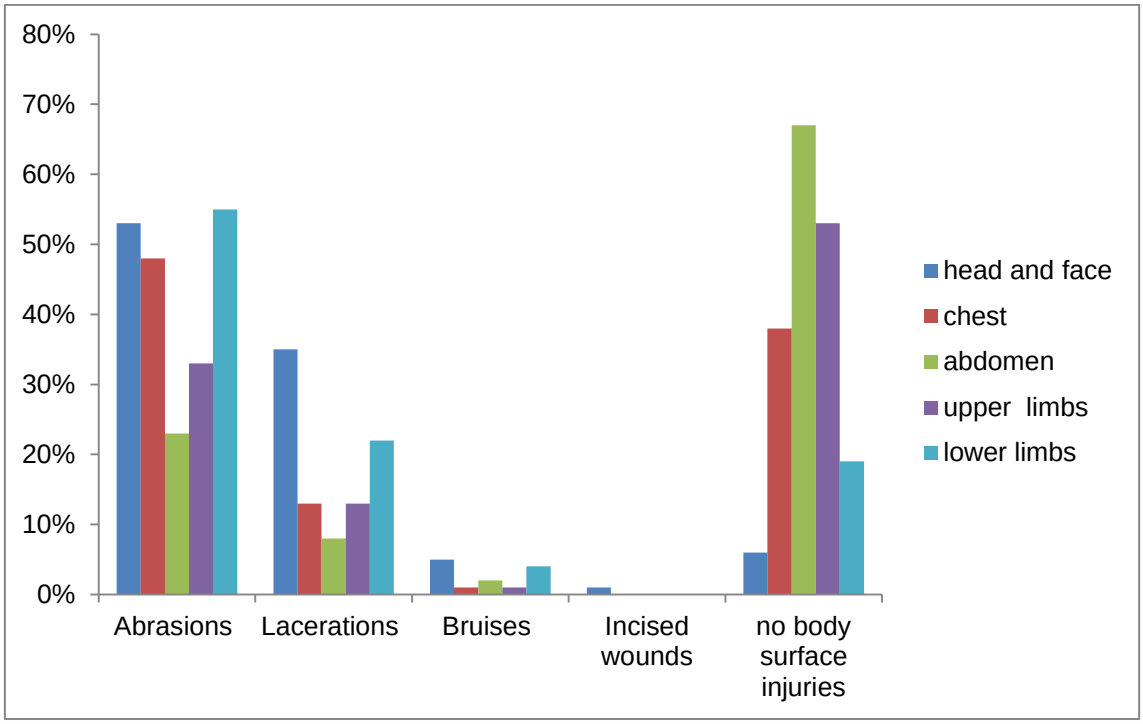


Figure 4.9 Body surface injuries

Majority of the pedestrians in the study (figure 4.10) sustained head injuries (88%) followed by chest injuries (81%) and lower limb injuries (68%). There were least cases of cervical spine and pelvic injuries (20%) noted.

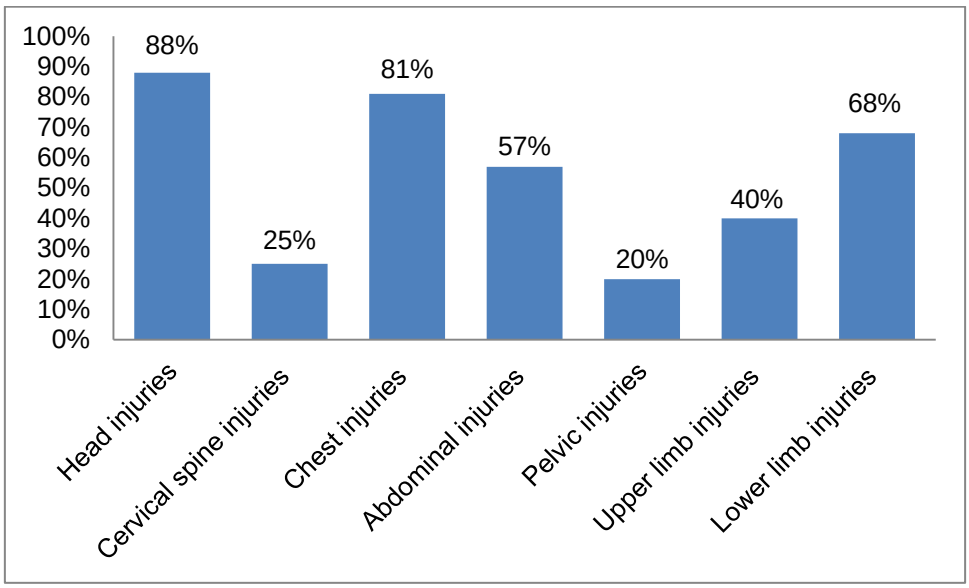


Figure 4.10 Summary of sustained injuries

These internal injuries are now outlined as per region:

Head and facial injuries

A total of 59% of pedestrians had skull fractures (table 4.1). The most common type of skull fractures that were sustained were the hinge fracture (17%), linear fracture (15%) and comminuted fracture (16%). There was a higher incidence of intracranial injuries (85%), with a higher occurrence of subarachnoid haemorrhage (35%) and subdural haemorrhage (35%). There were also a few reported cases of decapitation (3%) and pontomedullary rent (3%).

Table 4.1: Head and facial injuries

	Frequency	Percentage
Decapitation		
Yes	2	3
No	63	97
Skull Fracture		
Hinge Fracture	13	17
Ring Fracture	2	3
Linear Skull Fracture	11	15
Comminuted Skull fracture	12	16
Crushed Skull	1	1
Open Skull Fracture	5	7
No skull fracture	31	41
Intracranial injuries		
Epidural haemorrhage	0	0
Subdural haemorrhage	30	35
Subarachnoid Haemorrhage	30	35
Intracerebral hematoma	1	1
Pontomedullary rent	3	3
Diffuse axonal injuries	2	2
Extruded and pulpified brain	8	9
No intracranial injuries	13	15

Cervical spine injuries

Cervical spine injuries were noted in 25 % of the pedestrian fatalities (table 4.2) and most of those pedestrians sustained upper cervical injuries (17%).

Table4.2: Cervical spine injuries

	Frequency	Percentage
Upper cervical injuries	11	17
Lower cervical injuries	5	8
No cervical injuries	49	75

Chest injuries

The study (table4.3) showed that there was a high incidence of rib fractures (57%). This was associated with hemothorax (40%), lacerations/ contusions of the lungs (46%) and a few cases of lacerated/contusions on the heart (table 4.3). There were a few cases of lacerated or transected thoracic aorta (29%) and mostly were located on the descending aorta (42%) followed by the ascending aorta (26%). There were also a few cases of dislocated or fractured thoracic spine (23%).

Table 4.3: Chest injuries

	Frequency	Percentage
Rib fractures		
Yes	37	57
No	28	43
Sternum Fracture		
Yes	8	12
No	57	88
Hemothorax		
Yes	26	40
No	39	60
Lacerations or contusions of the lungs		
Yes	30	46
No	35	54
Lacerations or contusions of the heart		
Yes	11	17
No	54	83
Transected or Lacerated aorta		
Yes	19	29

No	46	71
If yes , state location of the laceration/transection		
Ascending aorta	5	26
Descending aorta	8	42
Arch of aorta	2	11
Location not specified	4	21
Hemopericardium		
Yes	2	3
No	63	97
Fracture or dislocation of thoracic spine		
Yes	15	23
No	50	77
Transected thoracic spine		
Yes	7	11
No	58	89

Abdominal injuries

There were a few cases of lumber spine injuries reported, and 9 % of those pedestrians had fractured/ dislocated lumber spine and 6% had transected spinal cord (table 4.4.)

Table 4.4: Abdominal injuries

	Frequency	Percentage
Ruptured internal organs		
Yes	7	11
No	58	89
Lacerated internal organs		
Yes	25	38
No	40	62
Fracture / dislocation of lumbar spine		
Yes	6	9
No	59	91
Transected lumbar spinal cord		
Yes	4	6
No	61	94
Transected torso		
Yes	0	0
No	65	100

Pelvic injuries

The study showed that the common pelvic injury (table 4.5) that was sustained was fracture/ separation of the pubic symphysis (14%).

Table 4.5: Pelvic injuries

	Frequency	Percentage
Extruded intestines or testes		
Yes	4	6
No	61	94
Separation or fracture of the pubic symphysis		
Yes	9	14
No	56	86
Dislocation of the sacroiliac joint		
Yes	2	3
No	63	97
Fracture of the pubic ramus		
Yes	3	5
No	62	95
Bladder injuries		
Yes	2	3
No	63	97

Upper limb injuries

It was noted that the pedestrians had fractured long bones (38%) and with a few cases (2%) of traumatic limb amputations (table 4.6).

Table 4.6: Upper limb injuries

	Frequency	Percentage
Fractured long bones		
Yes	25	38
No	40	62
Traumatic amputations		
Yes	1	2
No	64	98

Lower limb injuries

The study (table 4.7) showed that there was a high incidence of fractured long bones (62%) and a few cases of traumatic limb amputations (6%).

Table 4.7: Lower limb injuries

	Frequency	Percentage
Degloving wound		
Yes	0	0
No	65	100
Fractured long bones		
Yes	40	62
No	25	38
Traumatic amputations		
Yes	4	6
No	61	94

4.3 DISCUSSIONS OF RESEARCH FINDINGS

The research profiled pedestrian road traffic fatalities along the R71 road, which included highlighting the contributory factors of these fatalities. It also aimed at identifying the common locality of these fatalities. The type of injuries that were sustained were also outlined.

Contributory factors

Pedestrian factors

The study showed that there were more male than female pedestrians that demised. This was an overall similar trend seen in both developing and developed countries. Mexico, Ghana, Philippines and Sri Lanka are some of the developing countries that show males being more involved in pedestrian road traffic fatalities (WHO, 2013; Damsere-Derry et al., 2009; Verzosa & Miles, 2016; Edirisinghe, Kitulwatte & Senarathne, 2014). Studies in developed countries such as the United States of America (USA), France and Finland also found males to be more involved in road traffic crashes (WHO, 2013; Martin,

Lardy & Laumon, 2011; Malin, Silla & Mladenovic, 2020). The reasons for this trend were not stated. However, it could be that men are likely to engage in risky behaviour than female counterparts.

The affected age group in the study were mostly adults aged between 20-39 years of age, with the least deaths seen in children between 0-9 years. This was a stark contrast with previous studies done in other developing and developed countries that showed older adults aged 60 years or 65 years or above to be more affected (Verzosa & Miles, 2016; Edirisinghe et al., 2014; Martin et al., 2011; Martinez-Ruiz et al., 2019). In the present study, older adults over 60 years contributed only 12 % of the total deaths. Elderly people have a slow reaction time, reduced vision and reduced sensory inputs (Chong et al., 2018). This was also a contrast to a study done in the Western Cape Province of South Africa, which showed that more fatalities were seen in male children under the age of 5 years (WCIMP 2018).

Environmental factors

- Timing

In the present study, most fatalities were noted to occur from evening to dawn. The higher incidence of pedestrian deaths from night to dawn may be associated with darkness and poor visibility. It was also noted that majority of the pedestrians wore dark colours with no reflector on. This is a concern as those wearing dark colours and no reflectors are at risk of pedestrian crashes and fatalities at nigh time or dawn (WHO, 2013).

These pedestrian fatalities in the study were more frequent on weekends. The WHO (2013) found that fatal pedestrian collisions occurred on weekends (Saturday and Sunday). Reasons were not provided in the literature, but it may be because people travel and socialise more over the weekends.

The pedestrian road traffic fatalities occurred throughout the year, but peaked in December, followed by February and these are within the summer season. The National Injury Mortality Surveillance System (NIMMS) show that transport related deaths in Gauteng peak in September (NIMMS 2013) and in September (spring) and December (summer) in Mpumalanga Province. The NIMMS study , however, reported on transport related deaths and not a specific category within these transport related deaths. No reasons where provided for the specific seasonal trends in the previous studies. It is of the researcher's opinion that December month is associated with many celebrations (festive season), increased movement of people, cars and an element of alcohol intoxication by both drivers and pedestrians. The pedestrian fatalities then declined in January and started increasing again in February in the study. It is of the researcher's opinion that this could be due to individuals being low on cash in January following expenditures during December, thus less movement in January.

- Locality

The majority of these pedestrian road traffic fatalities occurred between Mankweng, Paledi Mall area up to Mentz village (Area 3). This was followed by the area between Nobody villages to Mamadimo/Moremadi Park. Within this region, there are residential areas immediately on either side of the road, schools, a mall as well as alcohol outlets close to the road. Furthermore, the road is mostly dual carriageway and this is associated with high speeds (Mokoma, 2017). The researcher also noted that pedestrian crossing signs and marks are present on the road, however there are a few speed reducing measures to ensure that cars do slow down for pedestrians to cross. Another observation made by the researcher is reduced visibility due to fewer streetlights.

Injuries sustained by the pedestrians

Majority of the pedestrian fatalities had abrasions and lacerations on the head, chest, abdomen, upper limb and lower limbs. The most common injuries sustained by the pedestrians were head injuries, chest injuries and lower limb injuries.

Previous studies showed that head injury was the most common injury seen in pedestrian fatalities (Zivkovic, Nikolic, Strajina, Djonic & Babic., 2012), which was also the case in the present study. The common skull fracture in road traffic fatalities is the hinge fracture (Saukko & Knight, 2014). This was also noted to be the common skull fracture in the study. There were a few cases of extruded and pulpified brain which is an injury commonly found in run over pedestrians (Payne-James, Jones, Karch & Manlove, 2011).

Higher cervical spine injuries were more common that lower cervical spine injuries. Hyperextension of the neck results in upper cervical spine dislocation (atlanto-occipital level, C1-C2 and C2-C3). Such injuries are associated with pedestrians struck by a speeding car from behind (Spitz & Fisher, 2006; Reddy & Murty, 2014). There were also isolated cases of decapitation, and this type of injury is seen in run over pedestrians (Spitz & Fisher, 2006).

The study showed the common chest injuries were rib fractures, hemothorax and lacerated or contused lung. There were also a few cases of transected or lacerated aorta, which was found mostly on the descending thoracic aorta. Rupture of aorta may be seen in higher speeds (Burke, 2007).

Abdominal Injuries depend on the impact and vehicular speed. They may sustain ruptured internal organs, perforated intestine, lacerated mesentery and fractured lumbar spine (Saukko & Knight, 2016). In the study, the pedestrians sustained lacerated internal organs and ruptured internal organs. There were a few cases of lumber spine injuries reported with transected spinal cord.

The abrasions and bruises on the pelvic area may also indicate primary contact with the vehicle (Burke, 2007). In the study there were few cases of separation/fracture of the pubic symphysis and pubic rami fractures. Pelvic fractures are also common in run-over incidents (Burke, 2007), where the pelvis may flatten or the symphysis or superior rami fracture (Saukko & Knight, 2016). Spitz and Fisher (2006) report fractures of the pubic ramus from impact with the front fender of the car.

Bumper injuries include abrasions, lacerations and bruises upon impact with the vehicle; in addition, the pedestrians may sustain lower limb fractures. Abrasions and lacerations were seen on the lower limbs of the pedestrians in the study. There was a higher incidence of fractured long bones (62%) and a few cases of traumatic limb amputation. Traumatic amputation of limbs is associated with high-speed impact (Payne-James et al., 2011; Burke, 2007).

4.4 CONCLUSION

The study showed majority of pedestrian fatalities on the R71 involved males more than female counterparts. The fatalities were mostly seen in adults aged between 20 -39 years of age and least fatalities seen in children less than 9 years of age. Majority of those pedestrians were reported to be wearing dark coloured clothing with no reflector on. The pedestrian fatalities occurred throughout the week but more fatalities were seen from Friday to Sunday, and the peak time being between 18:00-06:00 (evening to dawn time). The fatalities occurred throughout the year, but peaked in December, followed by February, which are summer months. The majority of the accidents were reported between Mankweng and Mentz village (Area 3) followed by Nobody to Mamadimo park/ Moremadi Park (Area 2). Within those areas, there are residential areas, a mall, schools and liquor outlets close to the road. The other contributory factor may also be unlit roads, which worsens visibility.

The pedestrians sustained mostly head injuries with majority having intracranial injuries. There were few cases of decapitation. This was followed by a high occurrence of chest injuries and lower limb injuries. There were a few cases of severe whiplash injuries, transected aorta and traumatic lower limb amputations, which are suggestive of high-speed impact injuries.

CHAPTER 5

SUMMARY, RECOMMENDATIONS AND CONCLUSION

Chapter 5 will summarize the study findings, recommendations, limitations and conclusion.

5.1 SUMMARY OF THE STUDY

The study set out to profile pedestrian road traffic fatalities that occurred on the R71 road and admitted in PFPS. Therefore, a retrospective descriptive study was conducted which aimed to explore the contributory factors of pedestrian road traffic crash fatalities on the R71 road as well as to describe the types of injuries sustained by these of pedestrian.

There were 65 cases of pedestrian road traffic fatalities that demised on the R71 road that were studied. The study showed that males were more involved in pedestrian road traffic crashes and involved adults aged between 20-39 years. The fatalities occurred mostly from the evening to dawn and over the weekend. The majority of pedestrians were dressed in dark coloured clothing with no reflector. These fatalities occurred throughout the year but were more prevalent in December and peaked in summer. The majority of these pedestrian fatalities seen between Mankweng and Mentz village (Area 3), followed by Nobody to Mamadimo park/ Moremadi Park (Area 2), which have residential areas, a mall, schools and liquor outlets close to the road. Of note was Vikings and Boyne area (Area 4) which few pedestrian fatalities. This area had upgrades completed on the R71 road in 2015.

The pedestrians sustained mostly head injuries with majority having intracranial injuries. This was followed by a high occurrence of lower limb injuries. There were cases of severe whiplash injuries, transected aorta and traumatic lower limb amputations, which are suggestive of high speed impact injuries.

5.2 RECOMMENDATIONS

In order to reduce pedestrian fatalities, a multidisciplinary approach is required to deal with contributory factors. The study showed that majority of pedestrian fatalities occurred from the evening to dawn and those times are associated with darkness and reduced visibility thereby placing them at a higher risk of being involved in road traffic accidents.

It was further established that majority of pedestrians wore dark clothing with no reflector which coupled with reduced visibility placed them at a higher risk of being involved in road traffic fatalities. Continuous campaigns on safer road practices should be reinforced in order to improve pedestrian safety.

There were also pedestrian fatalities that occurred during the day when there is adequate lighting. From the researcher's observation, pedestrian crossing marks are present on the R71 road, as well as speed limits but are there enough speed reducing measures to ensure that indeed the vehicle drivers reduce the speed in order for pedestrians to pass safely. The relevant stakeholders, like SANRAL and Department of Roads and Transport, should review measures that will compel drivers to reduce their speed in order for pedestrians to cross the road safely.

The study also highlighted the locality of the pedestrian fatalities. The relevant stakeholders should review the localities of these pedestrian fatalities in order to see if any modifications could be implemented to the road infrastructure, and the practicality of that to ensure safer environment for pedestrians. The study showed few pedestrian fatalities at Vikings and Moria/ Boyne area along the R71 road and this is an area that had upgrades completed in order to improve pedestrian safety and vehicle congestion. This is encouraging that perhaps implementation of other measures on other high-risk areas along the R71 road may reduce pedestrian fatalities as well.

5.3 RESEARCH LIMITATIONS AND DELIMITATIONS

There were limitations in the study. The first limitation was missing hospital clinical records. This was a retrospective study and some hospital files/clinical records could not be retrieved. This resulted in a reduced sample size as those cases with missing clinical records were excluded. A reduced sample size may give underrepresentation or overrepresentation of results. The second limitation was incomplete data on weather elements and therefore weather elements could not be included in the study. The data was not available for certain weather elements as Polokwane is the only weather station with personnel while Mankweng and Haenertsburg have none. As a result, certain weather elements could not be available (Annexure E)

There were also delimitations in the study. The information on clothing of the pedestrians was not always documented in those that demised at the scene or was unknown in pedestrians that demised at the hospital. The second delimitation was exclusion of the role of alcohol as a contributory factor in pedestrian road traffic fatalities as it may be difficult to retrieve all the blood alcohol results due to the backlog at the Pretoria Forensic Chemistry Laboratory. Future studies could explore alcohol intoxication as a contributory factor in the pedestrian road traffic fatalities.

5.4 CONCLUDING REMARKS

The study profiled pedestrian fatalities on the R71 road and identified contributory factors of which some were highlighted in literature. The researcher believes that some of those factors such as pedestrian visibility, speeding vehicles (as demonstrated by the sustained injuries) should be addressed in order to improve the safety of pedestrians. Furthermore, the localities mostly associated with the pedestrian fatalities along the R71 road were identified. Further studies may be needed to overcome the identified limitations in the study.

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ANNEXURES

Annexure A: Data collection tool

Reference number

A. PEDESTRIAN FACTORS :

Demographics

Age

0-9yrs	10-19yrs	20-29yrs
30-39yrs	40-49yrs	50-59yrs
>60yrs		

Gender

Male	Female

Clothes

Reflector worn or bright clothing	No reflector / Dark clothes	Unspecified

B. ENVIRONMENTAL FACTORS :

Timing

Time

00:00-5:59	6:00-11:59	12:00-17:59	18:00-23:59

Day

Monday	Tuesday	Wednesday	Thursday
Friday	Saturday	Sunday	

Month

January	February	March	April	May
June	July	August	September	October
November	December			

Season

- Autumn: 1March-31 May
- Winter: 1 June-31 August
- Spring: 1 September - 30 November
- Summer: 1 December -28/29 February

C. LOCALITY

- Area 1: Myngenoegen, Dalmada and Mamahule
- Area 2: Nobody to Mamadimo/Moremadi Park and Nobody
- Area 3: Mankweng / Paledi to Mentz
- Area 4: Vikings & Boyne/Moria
- Area 5: Makgeng Village to Haenertsburg
- Area 6: R71 unspecified

D. INJURIES ON THE BODY

1. <u>Head and facial injuries</u>

Body surface injuries

- Abrasions
- Lacerations
- Incised wounds
- Bruise
- No body surface injuries

Decapitation

- Yes
- No

Skull fracture

- Hinge fracture
- Ring fracture
- Linear skull fracture
- Comminuted fracture
- Crushed skull
- Open skull fracture
- No skull fracture

Intracranial injuries

Epidural haemorrhage	Subdural haemorrhage	Subarachnoid haemorrhage
Intracerebral hematoma	Pontomedullary Rent	
Diffuse axonal injury	Extruded and pulpified brain	No intracranial injuries.

2. Cervical spine injuries

Upper cervical injuries (C1-C2)	Lower cervical injuries (C3-C7)	No cervical injuries

3. Chest injuries

Body surface injuries	Abrasions	Lacerations	
	Incised wounds	Bruises	No superficial injuries
Rib fractures	Yes	No	
Fracture of sternum	Yes	No	
Hemothorax	Yes	No	
Lacerations or contusions on the lungs	Yes	No	
Lacerations or contusions on the heart	Yes	No	
Transected or Lacerated aorta	Yes	No	
	Ascending aorta	Arch of aorta	

If present, location of the laceration

	Descending Aorta	Location unspecified
Hemopericardium	Yes	No
Fracture or dislocation of the thoracic spine	Yes	No
Transected spinal cord	Yes	No

4. <u>Abdominal injuries</u>

Body surface injuries: Abrasions | Lacerations | Bruises | Incised wounds | No superficial injuries

Ruptured internal organs	Yes	No
Lacerated internal organs	Yes	No
Fracture/dislocation of lumber spine	Yes	No
Transected lumber spine	Yes	No
Transected torso	Yes	No

5. <u>Pelvic injuries</u>

Extruded intestines or testis Yes No

Separation or fracture of the pubic symphysis Yes No

Dislocation of sacroiliac joint Yes No

Fracture of the pubic rami Yes No

Bladder injuries Yes No

6. Upper limb injuries

Body surface injuries Abrasions Lacerations Bruises

Incised wounds No body surface injuries

Fracture of long bones Yes No

Traumatic amputations Yes No

7. Lower limb injuries

Body surface injuries Abrasions Lacerations Bruises

Incised wounds No body surface injuries

Degloving wound Yes No

Fractured long bones Yes No

Traumatic amputations Yes No

ANNEXURE B: University Ethics Approval Letter

University of Limpopo
Department of Research Administration and Development
Private Bag X1106, Sovenga, 0727, South Africa
Tel: (015) 268 3935, Fax: (015) 268 2306, Email: makoetja.ramusi@ul.ac.za

TURFLOOP RESEARCH ETHICS COMMITTEE

ETHICS CLEARANCE CERTIFICATE

MEETING: 17 February 2021

PROJECT NUMBER: TREC/03/2021: PG

PROJECT:

Title:	Profile of pedestrian road traffic crash fatalities on the R71 road admitted at Polokwane forensic pathology services
Researcher:	TW Mphatja
Supervisor:	Dr MJ Selatole
Co-Supervisor/s:	Dr MI Hlahla
School:	Medicine
Degree:	Master of Medicine in Forensic Pathology

PROF P MASOKO
CHAIRPERSON: TURFLOOP RESEARCH ETHICS COMMITTEE
The Turfloop Research Ethics Committee (TREC) is registered with the National Health Research Ethics Council, Registration Number: **REC-0310111-031**

Note:

i) **This Ethics Clearance Certificate will be valid for one (1) year, as from the abovementioned date. Application for annual renewal (or annual review) need to be received by TREC one month before lapse of this period.**

ii) **Should any departure be contemplated from the research procedure as approved, the researcher(s) must re-submit the protocol to the committee, together with the Application for Amendment form.**

iii) **PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES.**

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ANNEXURE C: LIMPOPO DEPARTMENT OF HEALTH LETTER OF APPROVAL

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

Department of Health

Ref : LP_2021-03-009
Enquires : Ms PF Mahlokwane
Tel : 015-293 6028
Email : Phoebe.Mahlokwane@dhsd.limpopo.gov.za

Tebogo Mphatja

PERMISSION TO CONDUCT RESEARCH IN DEPARTMENTAL FACILITIES

Your Study Topic as indicated below;

Profile of pedestrian road traffic crash fatalities on the R71 road admitted at Polokwane forensic pathology services

1. Permission to conduct research study as per your research proposal is hereby Granted.
2. Kindly note the following:
   a. Present this letter of permission to the institution supervisor/s a week before the study is conducted.
   b. In the course of your study, there should be no action that disrupts the routine services, or incur any cost on the Department.
   c. After completion of study, it is mandatory that the findings should be submitted to the Department to serve as a resource.
   d. The researcher should be prepared to assist in the interpretation and implementation of the study recommendation where possible.
   e. The approval is only valid for a 1-year period.
   f. If the proposal has been amended, a new approval should be sought from the Department of Health
   g. Kindly note that, the Department can withdraw the approval at any time.

   Your cooperation will be highly appreciated

pp **Head of Department** **Date** 19/04/2021

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Fidel Castro Ruz House, 18 College Street. Polokwane 0700. Tel: 015 293 6000/12. Fax: 015 293 6211.
Website: http/www.limpopo.gov.za

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ANNEXURE D: PIETERSBURG –MANKWENG RESEARCH ETHICS APPROVAL LETTER

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF HEALTH

PIETERSBURG/MANKWENG RESEARCH ETHICS COMMITTEE (PMREC)

ENQUIRIES: Mr MA POOPEDI **DATE: 21 April 2021**

MANAGER: CLINICAL RESEARCH

ananiaspoopedi@gmail.com

REFERENCE : **PMREC 21 April UL 2021/C**

Date : **21 April 2021**

RESEARCHER : **DR MPHATJA**
(PRINCIPAL INVESTIGATOR)

RESEARCH : **POST-GRADUATE RESEARCH**

DEPARTMENT : **FORENSIC PATHOLOGY**

Protocol Title: Profile of pedestrian road traffic crash fatalities on the R71 road admitted at Polokwane Forensic Pathology Services.

CANDIDATE : **DR MPHATJA**

APPROVAL STATUS : **APPROVED**

The candidate is advised to consinder the following:

- In terms of reliability (section 6.6): consider the revisiting of a percentage of the records by the researcher or a colleague – compare originals with duplicates – calculate reliability.
- File records must be represented by study number instead of actual name and surname.

Signed.

PROF TAB MASHEGO

Prof TAB Mashego

Chairperson: Pietersburg/Mankweng Complex Research Ethics Committee

School of Medicine

University of Limpopo

REC 300408-006

ANNEXURE E: SOUTH AFRICAN WEATHER SERVICE COMMUNICATIONS

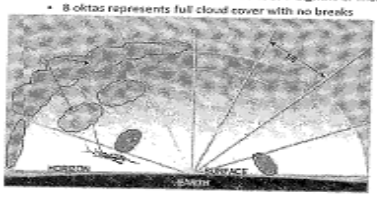
8/25/2021 Weather details for research purposes - tebogomphatja33@gmail.com - Gmail

Joe Matsapola <Joe.Matsapola@weathersa.co.za>
to me 6 May 2021, 14:59

Good afternoon Tebogo, please find the response regarding cloud cover and Polokwane is the only station that has cloud cover as it's a weather office with personnel manning the station. Mankweng become operational from the 1st March 2018.

Cloud cover is the fraction of the sky covered by all the visible clouds and is measured in oktas, or eighths of the sky.
If you look up at the sky, and mentally divide it into eight boxes, then imagine all the cloud you can see squashed into these boxes. How many boxes does the cloud fill? This is how many oktas of cloud there are.

- 0 oktas represents the complete absence of cloud
- 1 okta represents a cloud amount of 1 eighth or less, but not zero
- 7 oktas represents a cloud amount of 7 eighths or more, but not full cloud cover
- 8 oktas represents full cloud cover with no breaks



The other response to several questions asked i.e 1c. There is data for fog or mist, 2. Please send a disclosure document requesting data for Heenertsburg and please note that the said station only records rainfall with no other parameters like cloud cover and mist or fog. 3. The response to number 3 is stated above where the cloud cover is explained. I hope the answers cover all the areas you want clarity.

Kind regards

Joe Matsapola
Scientist: Climate Information
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Of Ecopark, Ecoglades Block B, Cnr Olievenhoutbosch and Ribbon Grass Streets, Centurion, 0157

Website: www.weathersa.co.za
Twitter: @SAWeatherServic
Facebook: South African Weather Service/ @WeatherService
USSD: Dial *120*72979
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https://mail.google.com/mail/u/0/#search/joe/KtbxLthVdScFrLWgpnsTqczCXBNMJKTKMg 1/1

LETTER FROM THE EDITOR

LEBOMA INVESTMENTS (PTY) LTD

REGISTRATION NUMBER: 2018 / 299676 / 07

TO WHOM IT MAY CONCERN

This letter serves to confirm that I, **Prof T.W Molotja**, have proofread and edited the research report for **Mphatja TW,** student number **210205552** entitled:

PROFILE OF PEDESTRIAN ROAD TRAFFIC CRASH FATALITIES ON THE R71 ROAD ADMITTED AT POLOKWANE FORENSIC PATHOLOGY SERVICES

The report is edited focusing on the following**:**

- Coherent writing.
- Eliminating spelling errors.
- Fluency in reading.
- Academic writing.

I therefore recommend for its submission.

Yours Sincerely Date: 07/09/2021