

**A RETROSPECTIVE STUDY OF THE PREHOSPITAL BURDEN OF TRAUMA  
MANAGED BY THE WESTERN CAPE GOVERNMENT EMERGENCY MEDICAL  
SERVICE**

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## ABBREVIATIONS

AfJEM	African Journal of Emergency Medicine
CAD	Computer aided dispatch
EMS	Emergency medical services
ePCR	Electronic patient care record
HIC	High-income countries
KTS	Kampala Trauma Score
KZN	KwaZulu-Natal
LMIC	Low- and middle-income countries
RTS	Revised Trauma Score
RTC	Road traffic crashes
SATS	South African Triage Scale
TRISS	Trauma and Injury Severity Score
WCG	Western Cape Government
WHO	World Health Organization

# **PART A: LITERATURE REVIEW**

## **Introduction**

The burden of trauma is one of the largest global challenges facing health care planners, policy makers, emergency care professionals and their patients globally (1). Over the last decade, the significance of this public health problem has received considerable attention worldwide. The available literature suggests that, not only is the burden of trauma disproportionately borne by populations worldwide, the morbidity and mortality rates are anticipated to steadily increase over the next decade (1,2).

Physical trauma is referred to as injury to living tissue caused by an extrinsic factor that threatens serious injury or death (3). While the definition of the term “injury” is fraught with certain complexities as it closely resembles that of disease, the theoretical definition of physiological damage to the body produced by energy exchanges that have relatively sudden discernible effects has been widely accepted (4). The clinical term “injury” appears to be the preferred term used in public health publications related to injury control and prevention (5). While the terms – trauma and injury - are used interchangeably in World Health Organization (WHO) report (6). For the purpose of this review, the term “trauma” or “traumatic injuries” will be used as appropriate.

Recent reports by the WHO suggest that trauma accounts for 10% of global mortality and continues to be among the leading causes of death and disability for persons aged between five and 29 years (1,2). Each year there are more than five million premature deaths and disabilities as a result of traumatic injuries worldwide (1,4). With a trauma related death occurring every six seconds somewhere in the world, it is paramount that global action is taken to address this public health crisis (1,2).

## **Literature review objectives**

This literature review aims to describe the burden of trauma (morbidity and mortality), the various mechanisms of traumatic injuries and associated epidemiological data related to traumatic injuries worldwide. These are areas of focus in the associated research study that aims to describe the prehospital trauma burden in a province of

South Africa. Lastly, the review of the available literature will aid in determining potential knowledge gaps related to the burden of trauma managed in low- and middle-income countries (LMICs), particularly South Africa.

### **Search Strategy**

An electronic search of the Science Direct, EBSCO host, and MEDLINE databases was conducted to identify relevant published articles. Furthermore, the African Journal of Emergency Medicine (AfJEM) was used to refine and specifically search for Afrocentric publications. Publications found on these mediums formed the foundation of this literature review, and all sources of literature are referenced where appropriate.

The search strategy used key words and phrases related to five main areas of this review: the burden of trauma, trauma and injuries, prehospital setting, sub-Saharan Africa and epidemiology. These included, but were not limited to:

- Burden of Trauma OR Burden of Injury OR Trauma OR Trauma Workloads OR Injury OR Injury Workloads)
- Prehospital OR Out-of-hospital OR Emergency Medical Service OR EMS OR in the field
- Epidemiology OR characteristics OR features

Search limiters were predetermined to ensure that included literature was aligned and contextualized to current disease profiles and health care systems.

Search criteria:

- Publications available in the English language
- Publications related to prehospital emergency care or emergency medical services, as the inclusion of populations managed within emergency departments are not within the scope of this review
- Articles published between 2000 and 2018, as literature would be aligned to current disease profiles and trends

- All types of articles, reports, reviews and publications available on the databases used

Abstracts of the publications attained during the searches were read, and relevant full text articles were retrieved for review. The reference lists of the Afrocentric trauma publications were also reviewed to uncover any relevant additional publications.

### **The burden of trauma**

Trauma is an emergent public health problem and accounts for 10% of the global burden of disease, approximately 1.7 times more than the combined fatalities as a result of HIV/AIDS, malaria and tuberculosis worldwide (2,6). The WHO injury and violence report suggests that more than five million people are subjected to premature death as a result of traumatic injury each year (1). With trauma projected to be the fifth leading cause of death and fourth leading cause of ill health by 2030, immediate global action is required (1,7).

The burden of trauma continues to be among the leading causes of death and disability in both LMICs and high-income countries (HIC), with the former accounting for 90% of trauma related fatalities worldwide (1,7). It is evident that large disparities in the impact of this burden and the quality of life following trauma incidents exist between HIC and LMICs, which is particularly important as 80% of the world's population resides in the LMICs (2,8,9).

A study describing the trauma mortality patterns in different economic levels observed that prehospital mortality rates in LMICs were more than 20% higher than those reported from HICs (9). Earlier studies demonstrated similar results and reported that critically injured trauma victims were six times more likely to die in LMICs as opposed to HICs (6). The trauma outcome disparity between HICs and LMICs has been described for over a decade, yet insufficient progress has been made to understand the emergency care needs of the LMIC trauma burden. Further highlighting the disparity between HICs and LMICs, the South-East Asia and Africa region accounts for 38% of the global population but experiences more than 50% of the trauma burden and accounts for 50% of the disability adjusted life years lost due to trauma (10). This

region, however, only accounts for 2.5% of global funds spent on health care resources (10).

The number of fatalities is not the only figure that matters, millions more are left with temporary or permanent disability as a result of preventable trauma. It is suggested that for each trauma related fatality, between 10 and 50 injured patients survive with temporary or permanent disability (1,11).

The burden of trauma in Africa and other LMICs is poorly reported on and studied (12,13). Where available, the publications describe the disparities borne to LMICs by reporting mortality rates that outweigh that of HICs. A review of the trauma burden in sub-Saharan Africa suggested that global mortality rates have generally decreased. However, rates of trauma deaths in Africa are slow to follow this trend and were as high as 100 per 100 000 population (14,15). A study nearly a decade later reported that mortality rates in South Africa alone increased by 50% per 100 000 population (16). The burden of trauma was further reported to be the second leading cause of mortality in Africa in the WHO 2008 report (17).

South Africa suffers from a quadruple burden of disease; pre-transitional causes, non-communicable diseases, HIV/AIDS and lastly trauma which accounts for a substantial proportion of death and disability (18). The overall reported injury mortality rate of 157.8 per 100 000 population in South Africa is almost double that of the global average (16). In South Africa, an estimated 51 242 trauma related fatalities occurred in the year 2016, a marginal decrease from the 52 493 reported in 2009 (19,20). These reports further highlight the unique trauma burden within South Africa, as the five-leading causes of trauma related fatalities are not similar to those depicted by the WHO or other LMICs.

During 2010, trauma was the second leading cause of death in KwaZulu-Natal (KZN), the second most populous province of South Africa; it further accounted for 102 000 prehospital activations (21). This equated to 12 per 1000 population for KZN, of which 80% of cases were reported to be serious in nature (11,21). This was the only published study describing the prehospital burden of trauma in South Africa found during this literature search.

Despite the fact that trauma remains a public health crisis with large disparities reported on the impact and outcome of this burden between HIC and LMICs, insufficient progress has been made to understand the emergency care needs in Africa and other LMICs. With South Africa's reported injury mortality rate nearly twice that of the global average and the unique trauma burden that does not facsimile global trends, the urgency to understand the emergency care needs of this LMIC could not be more crucial.

### **Mechanisms of traumatic injury**

The WHO injury and violence report describes the global impact of injury and violence, and successful types of interventions and policy responses used throughout the world (1). This report observed that road traffic crashes (24%), unintentional injuries (18%), suicide (16%), falls (14%) and homicide (interpersonal violence) (10%) are the main contributors to trauma related mortality worldwide (1). While the burden of trauma experienced by LMICs remains poorly described, these reports might not appropriately describe their trauma burdens.

Road traffic crashes (RTC) has been reported to be the leading cause of death among the youth and young adults worldwide (22). Africa, comprising predominantly of LMICs, endures the largest consequence of RTCs worldwide. The WHO reports Africa to have the highest RTC mortality rate of 26.6 per 100 000 population (22,23). Nigeria, a country in Africa is reported to experience RTC related mortality rates of 162 per 100 000 population (24). This is eight times more than the global average of 20.7 per 100 000 population for RTC fatalities (2,12,24). A population-based injury analysis in other African countries, Tanzania and Ghana suggested RTCs are responsible for up to 86% of trauma related hospital admissions (10), whereas in South Africa, RTCs accounted for 33.8% of trauma related fatalities (19,25). In the absence of national trauma registries and limited epidemiological studies in Africa, the variance in the contribution of RTCs to the trauma burden between LMICs around the world is not known. However, several reports suggest that many of the LMICs in Africa are suggested to bare a similar burden (24,26).

The WHO injury and health report suggests global rates of homicide at 8.8 per 100 000 population, accounting for 10% of all trauma related fatalities worldwide (1). In South Africa, homicide was reported to be the leading cause of trauma related mortality (27). According to the 2007 WHO bulletin and South Africa's second national burden of disease study, homicide rates were twice that of RTCs and four times that of intentional injuries (27,28). A provincial study conducted nearly a decade later suggested a decrease in homicide rates, from 68.4 in 2000 to 52.1 per 100 000 in 2015 in the Western Cape province of South Africa (25,29). These figures further emphasise the disparity in the burden borne by LMICs as well as the unacceptably high rates of homicide in the Western Cape of South Africa. Smaller single-center based studies in various healthcare facilities throughout South Africa suggest that RTC's and violence related injuries account for more than 70% of the trauma burden (11,30–32). Many of the publications suggest that a large proportion of these incidents are largely preventable. It was further concluded that a similar trauma burden is managed throughout the country. These extrapolations remain unchallenged as there are many regions within South Africa that lack epidemiological research relating to disease specific emergencies (13).

Other common causes of trauma related deaths worldwide, particularly in children, include burns, drowning and falls; these account for 6%, 7% and 8% of global trauma related fatalities respectively (1,33). South African national surveillance data from 2001 – 2004 reported a mortality rate of 7.9 per 100 000 population as a result of burn injuries (34). The increase noted nearly a decade later to 8.5 per 100 000 is one and half times greater than the global average (35). Drowning the most common trauma related fatality in children under the age of four years worldwide, of which 91% of this burden is borne to LMICs (1,36). The 2016 mortality statistics reported burns and falls to account for 4.1% and 0.6% of the other “external causes of accidental mortality“ in South Africa (37). Those residing in LMICs are four times more likely to die as a result of burn injuries when compared to those in HICs (33). However, the prevalence of fall injuries in HIC is predominantly higher than that of LMICs, particularly among older females (1,33). These unintentional injuries, in conjunction with occupational and environmental injuries, contribute significantly to the trauma burden (1).

Following RTCs and unintentional injuries, intentional injuries account for the third largest proportion of trauma related fatalities worldwide (1). Suicides are reported to be the leading cause of trauma related death for females worldwide (1). In South Africa, 14 per 100 000 people die as result of intentional injuries (25,27). This remains comparable to the global average of 14.5 per 100 000 population, which is nearly double that reported for the overall African region (27).

According to the WHO, the main contributors to the global trauma burden include: RTC, unintentional injuries, suicides, falls and homicides; with RTCs reported to be the leading cause of trauma related fatalities among the youth and young adults. Despite Africa having the highest RTC related mortality rate in the world, homicides are the leading cause of injury related mortality in South Africa. In the absence of national trauma registries and the limited trauma burden studies in Africa, the variance from global trends for other LMICs and parts of Africa remain unknown. This further highlights the need for epidemiological studies throughout Africa.

### **The distribution of trauma by age and sex**

The global trauma burden is disproportionately borne by the young and socio-economically active age groups (1). RTCs, suicides and homicides were reported to be the most frequent cause of trauma related fatalities between the ages of 15 – 49 years (1), while the elderly were reported to be more susceptible to fatalities as a result of falls (1,38). These trends appear to be consistent in both HIC and LMICs. However, the trauma distribution among children aged 0-4 years differs from those reported by the WHO, particularly in sub-Saharan Africa (1,35,39). Homicides and RTCs accounted for 32.2% of all trauma related fatalities in 2009 in South Africa (19). Earlier studies reported drowning to account for one in every four childhood trauma related deaths, remaining the overall leading cause of trauma related fatalities, this is still seen with recent reports by the WHO (1,39). They further went on to suggest that homicides and RTCs rates were either more common or marginally comparable to drowning in children in urban areas of South Africa (39). Authors of these studies suggest the region-specific conditions and socioeconomic factors experienced in LMICs were the most obvious contributors.

The WHO injury and violence report indicates that more males than females are subjected to trauma related fatalities (1). The male to female ratio ranges from 2:1, 3:1 and 4:1 for suicides, RTCs and homicides respectively (1). However, in regions such as South-East Asia and the Eastern Mediterranean, fatalities as a result of burn injuries are 1.5 – 2 times higher in females compared to males (1). Another example would be the leading cause of the unintentional injuries, falls, which has been associated with a higher mortality rate in older females than males (1,38). In the absence of high-quality epidemiological data from LMICs, sex, age and region-specific contributors cannot be clearly identified and used to generate appropriate injury and trauma care programs where they are most needed.

### **Classification of trauma severity**

Trauma scoring systems are essential in outcome studies. They promote the description and evaluation of injury severity and allow for correlation with the associated outcomes (6,40). Subsequently, this allows for the evaluation of trauma care system efficiency, which is an area requiring urgent attention with the current paucity in LMIC trauma care research. A wide array of trauma scoring systems exist, however only a few are used in sub-Saharan Africa.

In HICs, the Trauma and Injury Severity Score (TRISS) is the most frequently used tool for measuring trauma outcomes (41). TRISS takes patients' age, Injury Severity Score (ISS) and Revised Trauma Score (RTS) into account to predict trauma related outcomes (42). In addition to its efficacy, this tool is suggested to be particularly useful in performance improvements and patient safety programs by proposing improvements in trauma care practices (42). Recent studies evaluating the effectiveness of the TRISS model suggested that monitoring the efficiency of trauma care systems has become challenging, largely due to inestimable TRISS values as a result of missing data (42). Subsequently, a revised TRISS model was established, which negated the limitations of the previous version (41). The continual improvement of patient outcomes remains a priority, with further safety and error reductions still being attainable. The TRISS tool remains a mainstay feature in the continual improvement of patient outcomes by monitoring and identifying avoidable fatalities (41).

The ISS is the most commonly used tool to assess injury severity in patients subjected to blunt trauma (43,44). Earlier versions of the ISS have been widely criticized for only considering the worst injury in each anatomical region, likely underreporting injury severity (43). In response to this, the New ISS (NISS) was developed which aimed to improve the sensitivity of this index. With the addition of simple modifications, the NISS demonstrated its efficacy over that of the ISS with regards to better predicting functional outcome measures (44). This validated scoring system enables trauma teams to objectively determine the overall severity of traumatic injuries and assess the effectiveness of trauma care delivery (43,45). While the tool incorporates the three most severe injuries for each part of the body, the burden of data collection, complex nature of the tool and the large scale of data required, often limit its usage in regions with the highest incidence of trauma (46,47).

The Kampala Trauma Score (KTS), a composite scoring systems that includes different physiological parameters and anatomical injury ranking system than that of the RTS (48). It was developed for resource limited settings such as sub-Saharan Africa, where access to technology often limits the accurate use of anatomical based scoring systems (NISS and TRISS) (48). The KTS requires significantly less variables, which primary include routinely assessed and captured physiological parameters in any health care setting, for inclusion in a single algorithm which is used across all age groups (49). A study in Uganda validated the KTS and reported comparability in predicting hospitalization and mortality rates when compared to the RTS and ISS with fewer resources (48). A more recent study demonstrated the modified version of the KTS to significantly outperform the ISS in predicting trauma related mortality (50). The authors of these studies went on to conclude that the potential usage of the KTS as an effective tool for real time mortality prediction and inform trauma care referral systems within limited resources (48–50).

The South African prehospital setting and facility-based trauma care providers previously used a four-colour based triage system that has recently been replaced by a more robust model (51). As part of continuous health care improvement strategies, an effective method of determining patient acuity was implemented in South Africa after determining that the previously used version of Modified Early Warning Score (MEWS) was not appropriate for both medical and trauma patients, and an alternative

was needed (40). The South African Triage Scale (SATS) became the alternative, encompassing a five-level injury severity score which is calculated by incorporating a physiological based score, a list of discriminators and the option for senior health care providers to override acuity (51). Patient acuity is represented as colours; red (emergent), orange (very urgent), yellow (urgent), green (non-urgent) and blue (dead on arrival). The validity and reliability of improving the efficiency in emergency centres, reduction inpatient waiting times and the clinical predictability of this triage scale has been demonstrated across many LMICs and various South African health care facilities which all endure a similar overburden health care system (51–54). The literature suggests SATS to be well suited for resource limited settings as it is a general tool for both medical and trauma patients, while maintaining the efficacy demonstrated by other trauma specific triage tools.

### **Trauma care systems**

Trauma care systems consist of various organized components that are incorporated to provide a full range of emergency care (55). The value in this system truly lies in the coordination of the various components to ensure a seamless continuum of care (24). Many studies in HICs continue to confirm the widely held belief that reductions in mortality rates are associated with appropriately configured trauma systems (6,56). The WHO has emphasized the importance of such systems in LMICs to address the trauma burden, and subsequently provided guidelines for the establishment of one in resource limited settings (6,55). The key components in these guidelines closely resembled that of the American Heart Association chain of survival and is referred to as the chain of trauma care (57).

The chain of trauma care is one of the hall mark features advocated for by the WHO Essential Trauma Care project, which is aimed at addressing the disparities in trauma outcomes between HIC and LMICs (6,58). This is achieved through the organized trauma care programs that integrate the prehospital and hospital phases of trauma care (6,58). The African trauma chain of survival has been reported to consist of five distinct phases: trauma care system activation, bystander or first responder care, prehospital trauma care, emergency transportation and facility-based emergency trauma care (59,60). While South Africa was reported to be the only country in sub-

Saharan Africa to have all five functional components, fragmented yet functional components were present in many other LMICs (59).

Emergency trauma care, happens as part of a continuum offered by health services and cannot be isolated to a distinct phase (61). However, the first point of medical contact for those subjected to trauma emergencies often occurs in the prehospital setting. This is where prehospital trauma care is delivered, which is further defined as the rendition of acute and emergency trauma care by emergency medical services (EMS) outside of a fixed health care facility (61).

The WHO classifies EMS as a vital and integral component of any effective health care system (6,55). It is widely reported that the preponderance of fatalities as a result of trauma in LMICs occur in the prehospital setting (62). The Disease Control Priorities in Developing Countries second edition suggested, as a result of the growing trauma burden in LMICs, that these fatalities can be addressed by the presence of EMS as significant reductions of up to 45% in mortality rates and 36% in morbidity rates have been reported (61,63). A systematic review and meta-analysis on the impact of prehospital systems further reported a significant reduction of up to 25% in mortality rates in LMICs with prehospital trauma systems in place as opposed to those without (62). The value EMS offers any health care system in reducing premature death and disability remains unquestionable. However, the reporting on EMS capabilities, capacity and effectiveness remains an area that is poorly described (13,26).

An investigation in to the state of EMS in Africa during 2014 suggested that 61% of the continent had no evidence of a functioning EMS (26). Not all of Africa is besieged by the absence of standardized EMS structures as a component of the health care system. Countries such as South Africa, Zambia and Ghana have, over the past decade, developed organized statutory prehospital care systems (26,59,64). However, even in these countries EMS specific data still remains poorly reported on due to the absence of standardized national, regional and local trauma registries in conjunction with the paucity of Afrocentric research that depict any region-specific disease or trauma burdens managed by EMS (26,58).

The aim of any EMS is to provide timely emergency care to persons with sudden and life-threatening injuries, thus mitigating needless mortality and long-term disability (62). Without prehospital trauma care, many victims with a relatively good probability of survival, may end up dying at the scene of the incident or on their way to hospital. In addition to this, trauma patients also need to be transported to the most appropriate health care facilities according to their condition and health care needs, which has demonstrated significant reductions in mortality rates (56). In Africa, the assumption that the majority of trauma patients do not receive organized trauma care remains unchallenged. While this may not be the case for those residing in South Africa as it is widely suggested to have the most organized and developed EMS in Africa (67), only assumptions can be made that these instances occur more frequently within the rest of Africa.

Trauma has been reported to be the leading cause of EMS activation in Africa, however not much is known about this burden (26). With EMS playing such a vital role in reducing morbidity and mortality from trauma, strengthening this link in the trauma chain could not be more important. The paucity of EMS specific data, particularly in LMICs, has been identified in various publications, leaving many assumptions and health care solutions advocated for by HICs unchallenged (13). South Africa's EMS is reported to be the most organized and developed within Africa, with its case load being five times greater than any reported in Africa and it has recently introduced information management systems that promote the collection of EMS specific data (26,67–69). Surely this would be the ideal setting to develop region specific trauma care solutions based on actual trauma data from a LMIC that the rest of Africa can follow.

## **Summary and Conclusion**

The trauma burden disparity between HICs and LMICs has been described for over a decade, yet insufficient progress has been made to understand the unique trauma burdens, and develop region specific trauma care and injury prevention programs (10,70). The global trauma burden remains largely underreported as the majority of the publications and reports use mortality statistics alone to describe this devastating burden. It is evident that a need for reporting on non-fatal outcomes exists, in order to fully describe the trauma burden globally and more locally in South Africa.

There is a paucity of published data that describe the trauma burdens managed in LMICs. Furthermore, most of the studies originate from patients managed within health care facilities where available. This evidently leaves a gap in understanding the nature of injuries and emergency care required from EMS in LMICs.

With LMICs' high proportion of deaths attributed to trauma (10), strengthening the link in the emergency care continuum could not be more important. This is particularly relevant to South Africa, as its injury mortality rate is double that of the reported global average (16). Despite this disproportionate burden of trauma experienced by LMICs, the population of Africa and specifically South Africa, the emergency care needs and the epidemiology of the trauma burden managed is not known.

Recent publications related to prehospital research priorities in sub-Saharan Africa suggest that a paucity of epidemiological data exists (13). This is echoed by the WHO global call for epidemiological data to be used to decrease the burden of trauma and long-term disability (1,71). Previous publications describe populations managed by various health care facilities in the Western Cape, however little is known about the trauma burden managed by the WCG EMS or any other EMS in sub-Saharan Africa (72,73). It is evident that urgent research efforts are required to address the paucity of prehospital trauma data in sub-Saharan Africa.

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# **PART B: MANUSCRIPT IN ARTICLE FORMAT**

## **A retrospective study of the prehospital burden of trauma managed by the Western Cape Government Emergency Medical Service**

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## **Abstract**

**Introduction:** Trauma is one of the leading causes of premature death and disability in South Africa. There is a paucity of data describing the prehospital trauma burden in sub-Saharan Africa. The aim of this study was to describe the epidemiology and common trauma emergencies managed by the Western Cape Government emergency medical service (WCG EMS) in South Africa.

**Methods:** The WCG EMS call centre registry was retrospectively analysed for all trauma patients managed between 01 July 2017 to 30 June 2018. A descriptive analysis of the data was performed using standard procedures for all variables. To date, this was the first analysis of this dataset or any prehospital trauma burden managed in the Western Cape of South Africa.

**Results:** The WCG EMS managed 492 303 cases during the study period. Of these cases, 168 980 (34.3%) or 25.9 per 1000 population were trauma related. However, only 91 196 met the inclusion criteria for the study. The majority of patients (66.4%) were males and between the socio-economically active ages of 21-40 years old (54.0%). Assaults were the most common cause of trauma emergencies, accounting for 50.2% of the EMS case load managed. The patient acuity was categorised as being urgent for 47.5% of the cases, and 74.9% of the prehospital trauma burden was transported to a secondary level health care facility for definitive care.

**Conclusion:** This is the first report of the prehospital trauma burden managed in the Western Cape of South Africa. The Western Cape suffers a unique trauma burden that differs from what is described by the WHO or any other LMIC. It also provides the foundation for further research towards understanding the emergency care needs in South Africa and to support Afrocentric health care solutions to decrease this public health crisis.

## **Key Words**

Prehospital trauma care; Emergency Medical Services; Epidemiology; Trauma Burden.

## **African Relevance**

- Africa is reported to have the highest trauma related mortality rate worldwide.
- EMS is an important link in the African trauma chain of survival
- This is the first description of the epidemiology, common trauma emergencies and patient acuity of the prehospital trauma burden managed the Western Cape, South Africa.

## **What is new**

- This study identifies the exceptionally high rate of assault related emergencies in the Western Cape, as opposed to transportation related injuries described by the WHO injuries and violence report.
- This article further highlights the prevalence of young, healthy socio-economically active males, suffering the consequences of trauma across all variables reported on.

## Introduction

A trauma related fatality occurs somewhere in the world every six seconds (1). This global health problem accounts for 10% of the global burden of disease, and has become the leading cause of death and disability in children and young adults, in low- and middle-income countries (LMIC) as well as high-income countries (HIC) (2–4). The burden of trauma is disproportionately borne by the 80% of the world's population resident in LMICs, who account for 90% of global trauma fatalities (1–3,5). Those residing in LMICs are three-times more likely to die as a result of trauma than those in HICs (3).

Africa, comprising of predominantly LMICs, endures the largest consequence of this burden and accounts for one-fifth of the global trauma mortality burden (1). In 2016, Africa had the highest trauma related death rate of 26.6 per 100 000 people (3). Trauma was further identified as the leading cause for emergency medical service (EMS) activation (6). Despite the excessive prevalence of trauma in sub-Saharan Africa, the injury burden is poorly described (7). In South Africa, where the mortality rates are nearly double that of the global average, trauma is suggested to be the fourth leading cause of death (4,8,9). In 2016, 52 493 people died as a result of trauma, compared to the 51 242 fatalities reported in 2009 (4,9). While the reported rates in South Africa may have marginally decreased, the WHO suggests that trauma is steadily increasing and could possibly become the fifth leading cause of death across all age groups by 2030 worldwide (1). Therefore, immediate global action is required in addressing this public health crisis. There is evidently a need to report on non-fatal outcomes that could guide the development of Afrocentric prehospital trauma systems, as fatalities seem to be the only measurement currently used to describe the trauma burden in sub-Saharan Africa.

The majority of fatalities in LMICs occurs in the prehospital setting, yet many of these countries lack the infrastructure and capacity to deliver optimal prehospital emergency care (2,10–13). In the absence of an organized EMS, Mock et al reported mortality rates of as high as 80% in the prehospital setting of LMICs (11,14). This is particularly important as 61% of the African continent is without any formal EMS (6). Several studies have mentioned the significant role EMS play in reducing the trauma burden

in LMICs (12,15,16). The Disease Control Priorities in Developing Countries (DCP1 & 2), which is aimed at ascertaining reasonable responses for the mounting trauma burden in LMICs, suggested that a reduction of up to of 45% in mortality and 36% in morbidity rates could be addressed by the development of EMS (14,15). In light of this, the WHO classifies EMS as a vital and integral component of any effective health care system.

South Africa is an upper middle-income country comprising of nine provinces. The Western Cape is the third most populated province with 6.6 million people, based on 2018 mid-year statistics (17). The Western Cape Government (WCG) EMS is a publicly funded service providing free 24/7 emergency care and transportation by health care providers throughout the Western Cape. Annual EMS activations are estimated to be 500 000 throughout the province (18). KwaZulu-Natal (KZN), the second largest populated province in South Africa has a similar geography and EMS system to that of the Western Cape. As it is the only published South African study describing a prehospital trauma burden, brief comparisons and correlations will be made where appropriate.

The aim of this study was, therefore, to describe the prehospital trauma burden managed by the public sector EMS of the Western Cape in South Africa. In particular, we aimed to describe the: (i) epidemiology (ii) common types of trauma and associated dispatch priority, (iii) patient acuity and (iv) respective level of definitive care commonly required.

## **Methods**

This study is a retrospective review of all trauma patients managed by the state funded EMS in the Western Cape province of South Africa between July 2017 and June 2018.

The WCG EMS call centre registry contains computer aided dispatch (CAD) and electronic patient care records (ePCR) for each case managed by the WCG EMS. The CAD system collects non-clinical data related to physical resources allocated to each case, whereas, the ePCR database collects patient demographics and clinical data. De-identified data was extracted from the WCG EMS call centre registry and included all cases that were: (i) classified as trauma cases upon EMS activation, (ii) had

complete CAD records and (iii) had corresponding complete ePCRs. Interfacility transfers and medical cases were excluded. The dataset of outcome measures included basic patient demographics, causes of injury/trauma, patient acuity, dispatch priority and level of definitive care required.

Patient demographics and the modality of trauma were categorised in accordance with the WHO injury and violence report (1). Trauma modalities were divided into five groups, namely assaults (violence inflicted by others), transportation related (all mediums of transport), intentional (self-inflicted), unintentional (with burns, environmental and drowning injuries as sub-groups where available) and other injuries (occupational, falls or unknown) (1,19–21).

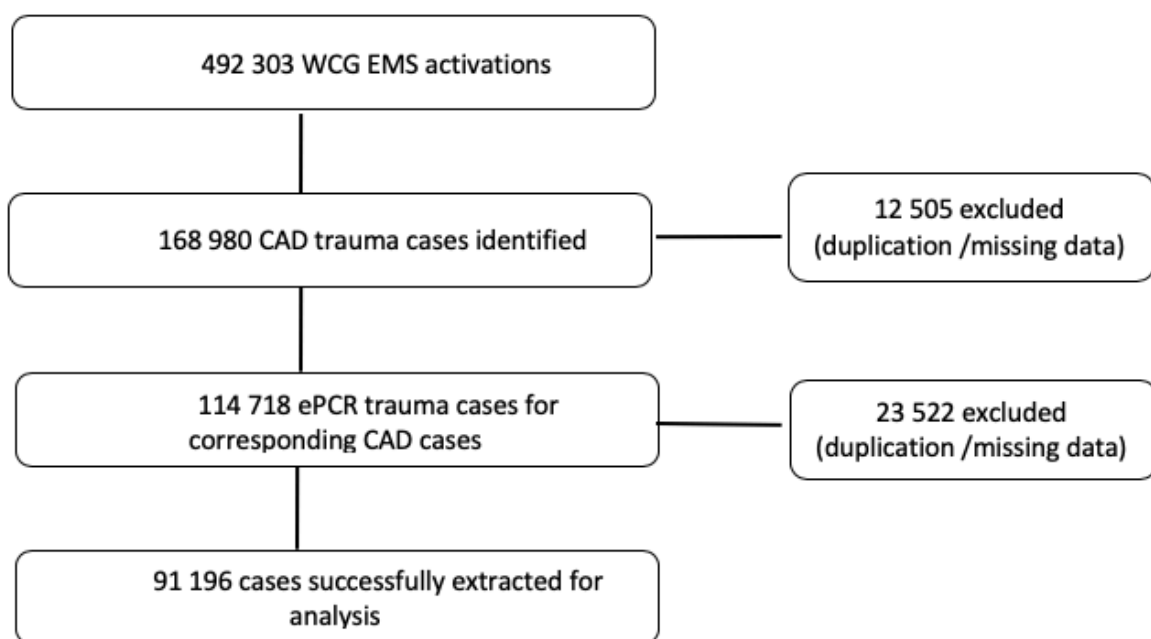
Patient acuity was characterised based on the classification of South African Triage Scale (SATS) (22). Patient acuity was defined as either red (emergent or life threatening), orange (very urgent), yellow (urgent), green (non-urgent) and blue (dead) (22). For the purpose of this study, community clinics and primary health care facilities were regarded as primary; regional and district facilities as secondary and highly specialized tertiary and quaternary facilities as the tertiary category (18,23). Date ranges were classified according to the weather related subgroups: Autumn (March – May), Winter (June–August), Spring (September–November) and Summer (December – February). Shifts periods were defined as either day shift (07h00 – 19h00) or night shift (19h00 – 07h00), these were the most common operational periods used at the time in the Western Cape.

The data was processed and analysed with Statistical Package for Social Science (SPSS) version 25 (Armonk, NY: IBM Corp). Simple summary statistics were used to describe all variables. Continuous data was described using means and standard deviation, while categorical data was reported as proportions. The chi square test was used to determine differences in distributions across variables. Statistical significance was considered at a p-value of less than 0.05.

Ethics approval for this study was granted by the University of Cape Town Human Research Ethics Committee (HREC REF: 693/2018) and WCG Department of Health EMS (WC\_201810\_034).

## Results

The WCG EMS had 492 303 activations during the study period, of which 168 980 (34.3%) were trauma related. Medical emergencies and interfacility transfers made up the remaining case volumes. Based on 2018 mid-year population statistics for the Western Cape, 25.6 per 1000 people were managed by the WCG EMS for a trauma related emergency (17). A total of 91 196 cases remained eligible for analysis after duplications, missing data and corresponding ePCR availability were excluded (Figure 1).



**Figure 1: Flow diagram depicting final study sample**

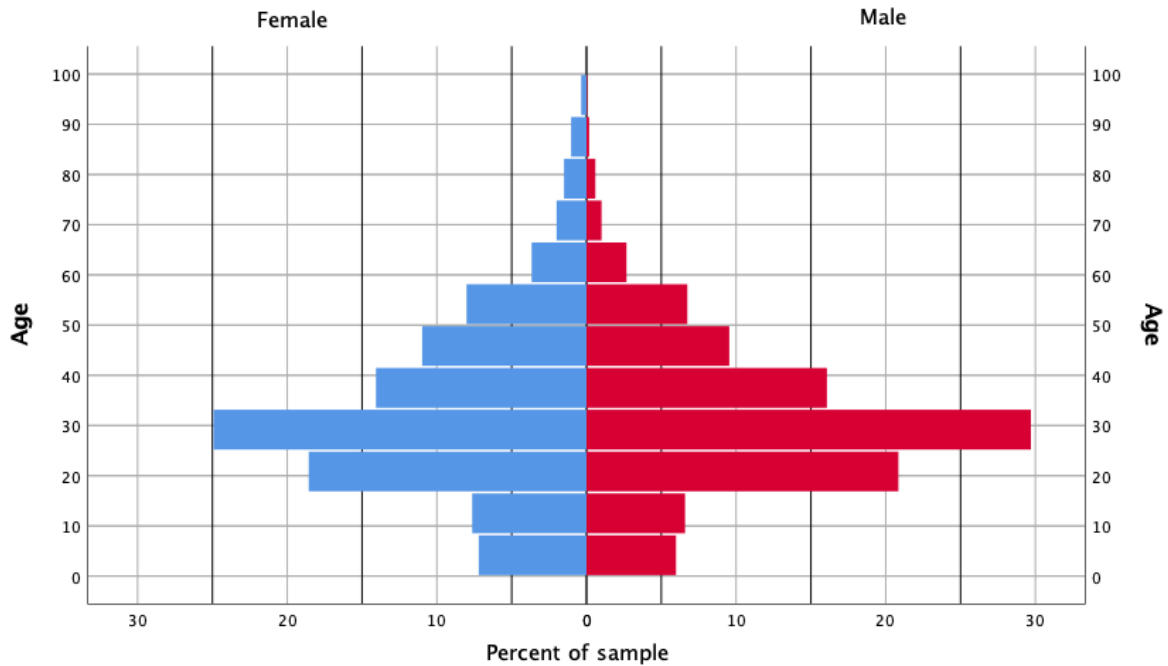
CAD: computer aided dispatch; ePCR: electronic patient care record; WCG EMS: Western Cape Government emergency medical service

The descriptive characteristics of the prehospital trauma patients managed are presented in Table 1. The mean ( $\pm$  standard deviation) age of all patients was  $31.6 \pm 15.8$  years. Young males between the socio-economically active ages of 21 – 40 years constituted the majority of the study sample ( $n=34\ 436$ , 37.7%). The paediatric population ( $\leq 13$  years) ( $n=9\ 213$ , 10.1%) of this study accounted for more than the accumulative proportion of those  $> 65$  years ( $n=2\ 792$ , 3.1%) (Figure 2).

**Table 1: Demographic characteristics of trauma patients managed by the Western Cape Government Emergency Medical Services**

<b>Characteristic</b>	<b>Assault</b>	<b>Intentional</b>	<b>Transport</b>	<b>Unintentional</b>	<b>Other</b>	<b>P value</b>	<b>Total</b>
<b>Sex</b>							
Male	34 036 (74.4)	3 185 (43.4)	11 813 (65.9)	10 449 (56.1)	1 043 (67.3)	<0.0001	60 527 (66.4)
Female	11 716 (25.6)	4 157 (56.6)	6 114 (34.1)	8 175 (43.9)	507 (32.7)		30 669 (33.6)
<b>Age</b>							
< 20	6 988 (15.3)	2 200 (30.0)	3 314 (18.5)	6 734 (36.2)	331 (21.4)	<0.0001	19 567 (21.5)
21 - 40	29 641 (64.8)	3 474 (47.3)	9 744 (54.4)	5 770 (31.0)	635 (41.0)		49 264 (54.0)
41 - 60	8 243 (18.0)	1 325 (18.0)	4 018 (22.4)	3 920 (21.0)	436 (28.1)		17 942 (19.7)
>61	880 (1.9)	344 (4.7)	851 (4.7)	2 200 (11.8)	148 (9.5)		4 423 (4.8)
<b>Date</b>							
Autumn	11 549 (25.2)	1 902 (25.9)	5 123 (28.6)	4 878 (26.2)	323 (20.8)	<0.0001	23 775 (26.1)
Winter	9 293 (20.3)	1 470 (20.0)	4 085 (22.8)	4 118 (22.1)	316 (20.4)		19 282 (21.1)
Spring	11 537 (25.2)	1 930 (26.3)	4 278 (23.8)	4 355 (23.4)	429 (27.7)		22 529 (24.7)
Summer	13 373 (29.2)	2 041 (27.8)	4 441 (24.8)	5 273 (28.3)	482 (31.1)		25 610 (28.1)
<b>Shift</b>							
Day shift	19 372 (42.3)	4 047 (55.1)	10 298 (57.4)	11 758 (63.1)	1192 (76.9)	<0.0001	46 667 (51.2)
Night shift	26 380 (57.7)	3296 (44.9)	7 629 (42.6)	6 866 (36.9)	358 (23.1)		44 529 (48.8)
<b>Total</b>	<b>45 752 (50.2)</b>	<b>7 343 (8.1)</b>	<b>17 927 (19.6)</b>	<b>18 624 (20.4)</b>	<b>1550 (1.7)</b>		<b>91 196</b>

*Values presented are counts with percentages in parentheses.  
P value <0.05 was considered statistically significant*



**Figure 2: Population pyramid by sex of the trauma burden managed by the Western Cape Government Emergency Medical Services**

Overall, 45 752 (50.2%) of the trauma emergencies managed were as a result of assaults, following the 17 927 (19.7%) as a result of transportation related injuries. This equates to an assault related emergency rate of 693.2 per 100 000 people based on 2018 population estimates for the Western Cape (17). Men (66.4%) experienced more trauma emergencies than woman (33.6%) ( $p < 0.0001$ ). Assault related injuries were the most common cause of trauma amongst males (56.2%) and females (38.0%) (Table 1), and accounted for 45.6% - 54.8% of the monthly call volume across the study period. Unintentional injuries, which included burns, drowning and environmental emergencies, were the second most common cause of trauma emergencies (20.4%) for the overall sample. The second most common cause of trauma emergencies for females were unintentional injuries (26.6%) and transportation related trauma for males (19.5%). Winter (21.1%) had a lower trauma call volume as compared to the summer (28.1%;  $p < 0.0001$ ).

Table 2 presents the dispatch priority and triage status by trauma category. The distribution of priority 1 and 2 calls differed by trauma category ( $p < 0.0001$ ).

Transportation related trauma injuries were categorized as priority 1 cases 99.1% of the time, with intentional injuries categorized as priority 1 in 63.8% of cases. Interestingly, 74.3% of unintentional injuries and 36.4% of intentional injuries were dispatched as priority 2 cases. Assault demonstrated a similar distribution as that of unintentional injuries across dispatch priority categories (38.2% P1; 61.8% P2).

Almost half of the sample were deemed urgent (47.5%) according to the SATS, followed by non-urgent cases (25.5%). The distribution of SATS acuity differed by trauma category ( $p < 0.0001$ ). Assault injuries accounted for the majority of cases across all acuity categories, in particular 48.4% of emergent and 41.4% of very urgent cases. Unintentional injuries was the second most common cause of patients being categorised as urgent (23.1%) and non-urgent (20.7%) respectively, while transportation related injuries accounted for the second most common cause of emergent (30.5%), very urgent (26.7%) cases and prehospital fatalities (38.9%).

With the majority of the sample being urgent or non-urgent, it is appropriate that 74.9% and 17.4% of the sample were transported to secondary and primary level health care facilities respectively. The second smallest percentage of the sample were deemed emergent (7.3%) according to SATS and only 7.1% ( $n=6440$ ) were transported to a tertiary facility for specialised care; whereas the remaining 0.8% were taken to the most appropriate mortuary.

**Table 2: Distribution of dispatch priority and triage status by trauma emergency**

<b>Characteristic</b>	<b>Assault</b>	<b>Intentional</b>	<b>Transport</b>	<b>Unintentional</b>	<b>Other</b>	<b>P value</b>	<b>Total</b>
<b>Dispatch Priority</b>							
Priority 1	17 419 (38.2)	4 668 (63.8)	17 763 (99.1)	4 790 (25.7)	575 (37.1)	<0.0001	45 215 (49.5)
Priority 2	28 161 (61.8)	2 675 (36.4)	164 (0.1)	13 834 (74.3)	975 (62.9)		45 809 (50.2)
<b>Patient acuity</b>							
Non-urgent	13 994 (30.6)	1 474 (20.1)	2 647 (14.8)	4 807 (25.8)	322 (20.8)	<0.0001	23 244 (25.5)
Urgent	20 960 (45.8)	3 149 (42.9)	8 360 (46.6)	9 996 (53.7)	841 (54.3)		43 306 (47.5)
Very Urgent	7185 (15.7)	2 110 (28.7)	4 629 (25.8)	3 091 (16.6)	305 (19.7)		17 320 (18.9)
Emergent	3217 (7.0)	599 (8.2)	2024 (11.3)	720 (3.9)	80 (5.2)		6 640 (7.3)
Dead	396 (0.9)	11 (0.1)	267 (1.5)	10 (0.1)	2 (0.1)		686 (0.8)
<b>Total</b>	<b>45 752 (50.2)</b>	<b>7 343 (8.1)</b>	<b>17 927 (19.6)</b>	<b>18 624 (20.4)</b>	<b>1550 (1.7)</b>		<b>91 196</b>

*Values presented are counts with percentages in parentheses.  
P value <0.05 was considered statistically significant*

A prehospital trauma mortality rate of 0.8% (95% confidence interval: 0.7-0.9%) was recorded during the study period (n=686), which equated to 752.2 deaths per 100 000 trauma patients managed by the WCG EMS. The majority of deaths occurred in males (70.4%), and patients aged 21- 40 years old (64.0%). Assault related injuries were the most common cause of mortality (57.7%).

**Table 3: Prehospital mortality patterns**

<b>Characteristic</b>	<b>Total (%)</b>
<b>Mortality /Sex</b>	
Female	203 (29.6)
Male	483 (70.4)
<b>Mortality /Age</b>	
< 20	56 (8.2)
21 - 40	439 (64.0)
41 – 60	167 (24.3)
> 61	24 (3.5)
<b>Mortality/Date</b>	
Autumn	66 (9.6)
Winter	212 (30.9)
Spring	242 (35.3)
Summer	166 (24.2)
<b>Mortality/Cause of Injury</b>	
Assault	396 (57.7)
Transportation Injury	267 (38.9)
Intentional Injury	11 (1.6)
Unintentional Injury	10 (1.5)
Other	2 (0.3)

## Discussion

This retrospective review provides the first description of the epidemiology, common trauma emergencies, patient acuity and disposition for the prehospital trauma burden managed in the Western Cape province of South Africa. In this study, we found that trauma constituted a substantial amount (31%) of the WCG EMS case load. A previous study in the KZN province of South Africa reported trauma to account for 15% of the EMS case load (21). The findings of our study suggests a 25.6 EMS trauma activation rate per 1000 population compared to the 11.6 per 1000 population previously reported in KZN (21,24). Elsewhere in the world, epidemiological studies from HICs reported trauma rates of between 19 – 30 per 100 000 population (25–27).

The most important finding of this study is the exceptionally high rates of assault injuries, which accounted for 50.2% of the case load managed. The magnitude of this occurrence can only truly be understood against the backdrop of global trends, in which the WHO injury and violence report suggests that it only accounts for 10% of the global trauma burden (1). We noted that assault accounted for the highest proportions among all categories measured, particularly the socio-economically active adults, critically ill (very urgent – emergency) cases and prehospital fatalities; yet more than half (61.8%) of cases were dispatched as priority 2. While these may all be areas of interest for targeted intervention strategies, the high proportions suggest that current methods used to prioritise assault calls, needs to be re-evaluated to reduce the overwhelming nature of this burden on the WCG health care system and subsequently the economy.

Earlier publications by the WHO reported homicide rates of 64.8 per 100 000 per population for South Africa (20), which is nearly six times that of the African region (28). The findings of our study suggest that for every 100 000 prehospital trauma emergencies managed, 434.2 people are likely to die as result of assault. The South African mortality statistics for 2016 describe the Western Cape as the province having the highest proportion of non-natural cause of death in South Africa, with an assault mortality rate superseding that of transportation incidents by almost four times (4). The findings of our study are also reinforced by similar trends and associations reported in the KZN province of South Africa, where assaults were the most common trauma

emergency managed by EMS (21). In comparison to the KZN prehospital trauma burden study, the prevalence of assault in KZN (39.7%) were considerably lower than the reported 50.2% in our study (21). These reports, in conjunction with the fact that the Western Cape prehospital trauma burden comprises of assault emergencies that are 30 – 50% greater than any reported sample in sub-Saharan Africa, bolster the label of “knife capital of the world” befallen the Western Cape in recent years (21,29,30)

In our study transport related injuries were the third most (19.7%) common cause of overall trauma, 30.5% less than the leading cause being assaults. Even though transportation related injuries only accounted for approximately one fifth of the trauma case load, almost all of them (99.1%) were considered priority 1 calls. We also noted it to have the second highest prehospital fatality rate (38.9%), after assault. Even though our study was on a local provincial level, it does not resemble the global findings in the 2018 WHO global status report on road safety, that reported transportation to be the leading cause of death for people aged 5 – 29 years worldwide (3). In contrast to our results, studies from both HIC and LMICs report a significant burden as a result of transportation related injuries rather than that of assault (16,29,31–34). The findings of our study are however reinforced by similar trends and associations reported in the KZN province of South Africa, where assaults were more common as opposed to transportation related injuries (21). Our study yields interesting prehospital transportation related injury statistics, as the WHO reports Africa to not only experience the largest RTC mortality rates in the world, but also that its citizens are three times more likely to die as a result of it (3). Whilst almost two thirds of transport related trauma patients (61.3%) were triaged into lower acuity categories (non-urgent – urgent), these injuries had the highest relative proportion of emergent cases (11.3%) compared to other types of trauma. The highest proportion of transport related injuries occurred during the Autumn months, which coincide with the Easter and school holiday festive period; recognized in South Africa as a period of excessive transport fatalities (35). Despite the current preventative efforts, transport related injuries remain a large part of the trauma burden in the Western Cape; and our results further suggest a need for continued intervention programs during the festive periods. The WHO have recognised transport related injuries to be a global problem, and have

echoed our sentiments on a global platform by emphasising strategies aimed at reducing this burden (3).

Unintentional injuries which included burns, drowning and environmental injuries were the second most common cause of trauma (20.4%). Males were subject to 12.9% more unintentional injuries than females in this sample. We also found that all subcategories (burns, drowning and environmental) except occupational related injuries to be more prevalent in the younger age groups. These findings are supported by local and international reports that describe drowning and burns to not only occur frequently in children, but that the largest proportion of this burden is borne by LMICs (1,36–38). Almost three quarters (74.3%) of unintentional injuries were categorised as priority 2 calls, and the majority of cases (70.2%) were deemed to be within the middle acuity category (urgent-very urgent). In conjunction with the fact that the largest proportion (36.2%) of injured were younger patients, we propose that age and the nature of the incident be taken into account when re-evaluating current prioritising methods. Furthermore, the majority of unintentional injuries were managed by EMS during day shifts (63.1%). We speculate, exposure to leisure and occupation related activities to mostly occur during the day.

We found that young males between the productive ages of 21 – 40 years (37.7%) were subjected to the preponderance of the trauma burden. Both of which were separately the most common characteristics across all mechanisms of injury, excluding intentional injuries which occurred 13.2% more among females <20 years old. These findings were consistent with previous publications based on epidemiological studies from LMICs, parts of South Africa and health care facilities within the Western Cape (21,29,39,40). According to the WHO, intentional injury has not only been described as one of the leading causes of trauma related mortality in woman worldwide, but has also been reported to likely supersede that of homicides by 2020 (28). In the current study, assaults and unintentional injuries were the most common emergencies experienced amongst females. This is likely reflective of the exceptionally high rate of gender based violence described in South Africa over the past decade (20,41). Our findings closely resemble the notion shared by the WHO that 45% of females in Africa will experience some form of assault (42). While this study gives us insight into the trauma burden experienced by woman and children, further

research is required to understand the nature of this burden and inform policy, practise and mitigating interventions.

### **Limitations**

This study has several limitations. This review is based on secondary data, appearing on a call registry of an organisation that has recently introduced point of care electronic capturing of data. A large portion of the prehospital trauma burden was not included in this analysis as a result of incomplete or missing corresponding ePCR records. In addition, the WCG EMS call registry data is likely to under represent the true prehospital trauma burden as the private EMS providers in the Western Cape were not included in this study.

### **Conclusion**

This study provides a description of the prehospital trauma burden managed by WCG EMS. Unexpectedly, assaults were the leading cause of trauma emergencies among males and females. Furthermore, the unique trauma burden does not facsimile those depicted by other LMICs nor global trends. The key findings of this study reveal exceptionally high rates of assault and road traffic accidents, this provides a bench mark against which to compare provincial data throughout South Africa and future trends, it has further highlighted the need to research the determinants of assault related emergencies and to evaluate current interventions aimed at reducing this burden. This study has not only provided preliminary epidemiological data in describing the Western Cape's prehospital trauma burden, it has highlighted the key areas requiring further investigation to inform policy and procedure, in particular the need to explore the prehospital trauma burden managed by all EMS providers in the Western Cape; and on a larger scale, the entire South Africa.

### **Author Contribution**

NA – Conceptualisation of the study design, primarily responsible for data extraction, analysis, interpretation and preparation of the manuscript.

CS,MM and PN - provided input with study design, data analysis, interpretation and manuscript preparation.

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**Conflict of interest**

The Authors of this study declare no conflict of interest.

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# **PART C: APPENDICES**

## **APPENDIX 1: Instructions for authors**

### **African Journal of Emergency Medicine: Instruction to Authors**

The journal selected for publication is the African journal of Emergency Medicine (AFJEM), as the study yields novel epidemiological data regarding prehospital emergency care in sub-Saharan Africa. Furthermore, this study can be used as a foundation for further research as where applicable, support the development of Afrocentric health care solutions.

The instruction for Authors can be found at the following link:

<https://www.elsevier.com/journals/african-journal-of-emergency-medicine/2211-419X/guide-for-authors>

## **APPENDIX 2: Research Protocol**

### **The burden of trauma managed by the Western Cape Government Emergency Medical Service: An Epidemiological Study**

The study is in partial fulfilment of the Master of Philosophy: Emergency Medicine degree.

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## **Declaration**

I, Mohammed Naseef Abdullah, hereby declare that the work on which this thesis is based is my original work (except where acknowledgements indicate otherwise) and the neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university.

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Date: 17 September 2018

## **The burden of trauma managed by the Western Cape Government Emergency Medical Service: An Epidemiological Study**

### **Abstract**

Trauma is a global health problem and accounts for a large proportion of death and disability worldwide. Trauma related deaths occur every six seconds, with 90% of these occurring in the low-middle income countries. Large disparities attributed to the burden of trauma are borne to low-middle income countries where 80% of the world's population reside.

With the largest proportion of premature trauma related deaths suggested to occur in the prehospital setting, it is vital that the prehospital emergency medical services align their development through using sound global recommendations aimed at decreasing the large proportion of death and disability. A recent call for epidemiological data by the World Health Organization (WHO) and region-specific emergency conditions in sub-Saharan Africa were in a response to the paucity of epidemiological data related to the patient's groups accessing prehospital Emergency Care, particularly in sub-Saharan Africa.

This study aims to assist in addressing this paucity by describing the epidemiology and common emergencies of the trauma burden managed by the Western Cape Government Emergency Medical Service (WCG EMS) between July 2017 and June 2018

A retrospective review of the burden of trauma managed by the WCG EMS will be conducted. Secondary data of approximately 200 000 prehospital managed trauma cases will be reviewed. This would be the first reported analysis of this dataset or any other prehospital burden of trauma in the Western Cape.

The findings could be used to inform Emergency Medical Service (EMS) management strategies, identify training interventions required and inform injury prevention programs and emergency care delivered within local communities.

## Background

Trauma, originating from the Greek word for “wound” refers to the consequence of an event causing immediate damage or harm to physiological or psychological well-being (1). The term injury is more aligned to the former and refers to physical harm or damage as a result of an abnormal energy transfer. These terms are used interchangeably in the literature when any form of physical harm is being explored (2).

Trauma is a global public health problem and accounts for a large proportion of death and disability worldwide (2,3). The World Health Organisation (WHO) injury and violence report suggests that each year more than five million people are subjected to premature death as a result of traumatic injury (4). With a trauma related death occurring every six seconds, up to 10 % of the worlds fatality rates are attributed to this ever growing concern (3,4).

The burden of trauma continues to be among the leading causes of death and disability in developing and developed nations, with the later accounting for 90% of trauma related fatalities (4,5). It is evident that large disparities in the impact of this burden and the quality of life exist between high and low- middle-income countries (LMICs), which is particularly important as LMICs make up 80% of the world’s population (3,6,7). With trauma projected to be the fifth leading cause of death and fourth cause of ill health by 2030, immediate global action is required (4,5).

Literature suggests that trauma related fatalities are steadily increasing and are disproportionately borne by LMICs (2,4). A study describing the trauma mortality patterns in different economic levels observed that prehospital mortality figures range from 59%- 82% in high income countries (HICs) and LMICs respectively (7). An earlier study demonstrated similar results and suggested that critically injured trauma victims were six times more likely to die in LMICs as opposed to high income countries (2).

The burden of trauma in Africa and other LMICs is poorly reported on and studied (8). A review of the trauma burden in sub-Saharan Africa suggested that global mortality rates have generally decreased, however rates of trauma deaths in Africa are slow to follow and were as high as 100 per 100 000 population (9). A study almost 15 years later suggests that 9% of Africa’s fatalities are attributed to trauma (10). The burden

of trauma was further reported to be the second leading cause of mortality in Africa in the WHO 2008 report (11). This report further went on to describe the concern in Africa when dealing with region specific emergencies, as mortality rates even though steadily decreasing are not on par with the significant reductions of up to 80% seen in other LMICs (11).

South Africa is experiencing a quadruple burden of disease, of which trauma accounts for a substantial proportion of death and disability (12). The overall reported injury mortality rate of 157.8 per 100 000 per population in South Africa is almost double that of the global average (13). In South Africa, an estimated 52 493 trauma related fatalities occurred in the year 2009; of which Homicide (36.2%), road traffic accidents (33.8%), suicide (12.3%), fire (3.8%) and drowning (3%) were identified as top five cause of trauma related fatality respectively (14,15).

Estimates in the year 2000 identified road traffic accidents (RTA) to be the fourth leading cause of trauma related fatality in South Africa; a steady increase has seen it become second leading cause of trauma related death in 2009 with a disproportionate increase expected in LMIC's over the next 20 years (16–18). RTA's have further been identified as the leading cause of trauma related fatalities globally (4,18,19). A study carried out nearly a decade later suggested a decrease in homicide rates from 74 – 40.1 per 100 000 population in the Western Cape of South Africa (20). The WHO 2001 injury and health report suggest global rates of homicide of 8.8 per 100 000 population (21), these figures when compared to that of South Africa further echo the disparity in the burden borne to low-middle income countries. With a largely preventable 16% of years of life lost attributed to this trauma burden which is suggested to be aligned to those identified by the WHO for LMICs (4,19,22), trauma still remains a public health problem in South Africa.

The number of fatalities is not the only figure that matters, millions more are left with temporary or permanent disability as a result of this predictable and preventable cause. A decline in the global average of years lived with disability (YLDs) has been noted in recent years, however the 6% of YLDs as a result of the burden of trauma is still a global health concern (3,4,22). Trauma was identified as the leading cause of death among youth aged 15 – 29, with the common global causes of injury expected

to rise in the ranking over the coming years(4). The immense direct and indirect impact as the above mentioned age groups are classed as the most economically active (10).

The preponderance of fatalities as a result of trauma in LMICs occur in the prehospital setting (23). The Disease Control Priorities suggested that the trauma burden in low-middle income countries can be addressed by presence of emergency medical services (EMS), significant reductions of up to 45% in mortality rates and 36% in morbidity rates have been reported (24,25). A systematic review and meta-analysis on the impact of prehospital systems further report, a significant decrease of up to 25% in mortality rates in LMICs with prehospital trauma systems in place (23).

The WHO classifies EMS as a vital and integral component of any effective health care systems, however it remains an area of neglected research (26,27).The value EMS offers any health care system in reducing premature death and disability remains unquestionable; however the reporting on EMS capabilities, capacity and effectiveness remains an area that is poorly reported on (28).

An investigation in to the state of EMS in Africa suggested that 33 (61%) of the 54 African countries had no evidence of a functioning EMS (28). Trauma was the leading cause of emergency care and transport, with transport to hospital rates of less than 10 000 per month in all African countries besides South Africa (28).The Western Cape, which is the third largest province in South Africa based on its population has a provincial EMS which manages over 500 000 cases each year (29). The Western Cape Government (WCG) EMS not only transports five times as many patients a month as compared to any of the other African countries; it does so in a country where 12% of fatality rates and 16% of years of life lost (YLL) are attributed to the trauma burden (16,19).

With South Africa's high proportion of deaths attributed to trauma (3,6), strengthening the link in the emergency care continuum could not be more important. Recent publications by Mould-Millman et al, aimed at determining prehospital research priorities in sub-Saharan Africa suggest that a paucity of epidemiological data exist, especially as it relates to region specific emergency conditions (27). This is further echoed by the WHO global call for epidemiological data to be used to decrease the

burden of trauma and long term disability (6). Previous publications describing populations managed by various health care facilities in the Western Cape exists, however little is known about the trauma burden managed by the WCG EMS or any other EMS in sub Saharan Africa (33,34).

Despite the large proportion of trauma experienced by the population of Africa and more specifically South Africa, the impact of the emergency care and trauma systems are not known. Furthermore, there is a need report on non-fatal outcomes, as fatalities seem to be the only measurement currently used to describe the trauma burden in South Africa.

### **Research Question**

What is the epidemiology and common emergencies of the prehospital burden of trauma managed by the WCG EMS between July 2017 and June 2018.

### **Aim and objectives**

The aim of this study is to describe the epidemiological characteristics of the trauma burden managed by the WCG EMS between July 2017 and June 2018.

In order to achieve this aim, the primary objectives of this study are:

1. To describe the epidemiology of trauma patients managed by WCG EMS between July 2017 and June 2018, including age, sex, incident location, date and time of injury.
2. To describe the type and dispatch priority of trauma emergencies managed by the WCG EMS between July 2017 and June 2018.

The secondary objectives of this study include:

1. To describe the prehospital mortality rates for the trauma patients managed by the WCG EMS.
2. To describe definitive care destinations that the burden of trauma managed by the WCG EMS were transported to.

3. To describe the level of emergency care provided to the burden of trauma managed by the WCG EMS.
4. To determine relevant crude associations for outcome variables and for hypothesis generation.

## **Methodology**

### Study Design and setting

The WCG EMS is a vital link in the continuum of emergency care offered to the 6.2 million people in the Western Cape (35). Being the first point of contact and providing lifesaving interventions during emergency situations, EMS aid in relieving the high mortality and morbidity rates owing to time sensitive and life-threatening trauma conditions (28).

A retrospective review of the burden of trauma managed by the WCG EMS between July 2017 and June 2018 will be undertaken. Secondary data of approximately 200 000 trauma cases managed and stored on the WCG EMS registry will be reviewed. This would be the first analysis of this dataset or any prehospital burden of trauma in the Western Cape.

The WCG EMS registry contains computer aided dispatch (CAD) and electronic patient care records (ePCR) for each case managed by WCG EMS. This comprehensive database is maintained, managed and only accessible to the information management department of the WCG EMS for medico-legal, quality assurance and health planning purposes. The CAD system collects all the non-clinical data related to the physical resource that EMS assign to each case. The ePCRs collect data regarding patient demographics, type of medical and trauma emergencies requiring care, patient acuity, prehospital assessment and diagnosis, medical interventions provided, comorbidities as well as disposition. The recent introduction of infrastructure has allowed the WCG EMS to collect and transfer data from CAD and mobile ePCRs as opposed to paper-based patient records which were still used during 2016.

The proposed study is a retrospective descriptive review and analysis of secondary data routinely captured and stored in the WCG EMS registry.

## Characteristics of the study population

This study would include all of the CAD and available ePCR's records for trauma patients requiring emergency care and transport by the WCG EMS between July 2017 and June 2018.

### Inclusion criteria are:

- All cases that were classified as trauma calls at dispatch and managed by the WCG EMS between July 2017 and June 2018.
- All trauma cases that have CAD data available on the WCG EMS registry.

### Exclusion criteria are:

- Patients managed during interfacility transfers (IFT), as these occur as IFT and not medical or trauma emergencies on the WCG EMS registry.

It should be noted that, where available, the CAD and corresponding ePCR data will be extracted from the WCG EMS registry. When ePCR facilities are unavailable, paper-based records are completed for patients managed by the WCG EMS. A robust estimate of the proportion of these situations is not known, but it is not within the scope of this study to review paper-based records. Therefore, CAD records will be included regardless of the availability of corresponding ePCR data, these instances will be reported on.

## Recruitment and enrolment

Once ethics approval is granted by the University of Cape Town Human Research Ethics Committee, permission will be sought from the WCG EMS to extract data from the registry. Approval will be obtained from the various department heads at the WCG EMS to extract and review this data. This is a review of secondary data and no direct patient contact will take place. Thus, no recruitment or enrollment of any participants will be required.

## Research procedures

The WCG EMS uses a computer aided dispatch (CAD) system to dispatch emergency vehicles to emergency cases. The case would be transferred to the emergency vehicles through the ePCR system, which would allow EMS personnel to record the relevant information related to each emergency managed. This data once completed will be synchronized and stored on the WCG EMS registry.

The secondary data required for this review will be extracted from the WCG EMS registry and captured onto a data extraction spreadsheet. Data meeting the inclusion and exclusion criteria will be extracted in the form of the following variables

CAD registry variables	ePCR registry variables
Incident Type	Case type
Priority	Priority
Case Type	Incident Type
Drainage area	Date of Call
Metro	Time of Call
Suburb	Sex
Classification	Age
Shift time	Disposition
Ambulance type	Final triage Color
Pick Facility	Crew Qualification
Dropped Facility	Declaration of death slip number
Patient mobility	Refusal Triage Transport Slip Number

## Data safety and monitoring

The secondary data obtained from the WCG EMS registry will be stored on a secure computer at the University of Cape Town Division of Emergency Medicine offices, which will be only accessible to the investigative team. This method of data storage will be employed as the student involved currently resides outside of South Africa. The specific deidentified data related to this study will be made available to the student by means of an encrypted, password protected data sharing platform that is currently approved for use by the WCG EMS.

## Data analysis

The relevant data will be exported from the WCG EMS registry to a Microsoft excel spreadsheet, thereafter it will be imported into the Statistical Package for Social Science (SPSS) programme which will be used for the analysis.

A descriptive analysis of the data will be performed by using standard procedures. The data will be analysed using simple descriptive statistics. Continuous variables will be described using means and standard deviations. Categorical data will be described using relative means and proportions. Standard Inferential statistics will be used including parametric and non-parametric tests where appropriate. A 95% Confidence intervals and corresponding  $p$ value  $\leq 0.05$  will be considered statically significant. Where applicable determination of clinical relevance will be discussed in relation to existing literature in the discussion section. Furthermore, trends and frequencies noted over time will be displayed by tables, histograms and bar charts.

Data Analysis Plan						
Objective	Objective	Variables	Data Type	Predictor/Explanatory Comparator	Test	Measure of occurrence/effect (2)
Primary	To describe the characteristics of trauma patients managed by WCG EMS during 2017.	Age Sex Location Date Time	Continuous variable Binary variable Nominal variable Nominal variable Nominal variable	N/A	N/A	Means and Standard Deviation (SD) n (%) 95% CI
Primary	To describe the type and dispatch priority of trauma emergencies during 2017	Trauma Type Dispatch priority	Nominal variables Binary variable	N/A	N/A	n (%) 95% CI
Secondary	To compare the dispatch priority for trauma emergencies during 2017 to other predictors.	Dispatch priority	Binary variable	Types of trauma Age Sex Time	Chi-square T Test	n (%) p value
Secondary	To describe the prehospital mortality rates for the trauma during 2017.	Mortality	Binary variable	N/A	N/A	n (%) 95% CI
Secondary	To compare the prehospital mortality rates for trauma emergencies during 2017 to other predictors	Mortality	Binary variable Nominal variable Nominal variable	Type of trauma Date and time Location	Chi square	n (%) p value
Secondary	To describe definitive care destinations that the burden of trauma managed by the WCG EMS were transported to.	Primary Secondary Tertiary	Nominal variables	N/A	N/A	n (%) and proportions Means and SD 95% CI

Secondary	To compare the definitive care destinations trauma emergencies were transported during 2017 to other predictors.	Primary Secondary Tertiary	Nominal variables	Dispatch priority Type of trauma Age Location	Chi-square	n (%) P value
Secondary	To describe the level of emergency care received during 2017.	Level of emergency care	Ordinal Variable	N/A	N/A	n (%) 95% CI
Secondary	To compare the level of emergency care during 2017 to other predictors:	Level of emergency care	Ordinal variable	Mortality Type of trauma Location	Chi-square	n (%) P value

## **Ethical Considerations**

This study will conform to the 2013 Declaration of Helsinki. Furthermore, it can be classified as low risk research as it involves the description and analysis of deidentified secondary data. The WCG EMS registry has previously been registered with the UCT Human Research Ethics Committee (HREC Ref R014/2017), and data extraction and data management in this study will be in accordance with the current approval.

Approval for this specific research study will be sought from UCT HREC and the Western Cape Department of Health, Emergency Medical Services.

### Descriptions of risks and benefits

The WCG EMS has recently attained the infrastructure that enables electronic capturing and storing of data related to the entire life cycle of emergencies managed. This research would serve as the first descriptive analysis of the WCG EMS registry of which the quality and completeness is not known. The epidemiological data, acuity of patients managed, and the common levels of emergency care rendered would provide novel information. This would not only aid in understanding the emergency care needs of a community managed by the WCG EMS, but also aid in improving the efficiency of emergency care rendered by EMS in South Africa. Furthermore, this analysis could be used to inform and justify injury prevention programmes, targeted training interventions and the large expenditure needed by EMS.

This research could be categorised as low risk as it entails the descriptive analysis of secondary data. There is no direct risk to the target population as confidentiality through coding and anonymity will be safeguarded throughout the research process. Confidentiality will be ensured, and no information contained in the WCG EMS registry will be shared with any party other than the primary researcher and the supervisors of this project. All data will be stored on a password protected device.

## Dissemination of findings

The findings of this research will be submitted for publication in a peer-reviewed journal and submitted to the University of Cape Town as a 60-credit minor dissertation. Furthermore, findings will also be shared with the respective department heads at WCG EMS. These findings could be used to inform EMS management strategies and training interventions required to improve emergency medical care delivered to local communities.

## Project Timeline

2018	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB
Summary Development	X	X								
Proposal Development		X	X							
EM-DRC				x						
Ethics				X	x					
EMS Approval					x					
Data Collection						x				
Data Analysis						X	x			
Compilation of Final Report							X	X	X	
Submission										X

## Budget

May 2018 – February 2019				
Item	Description	Unit Cost	No of units	Total Cost
Consumables				
1.Internet	Du : researcher current internet provider	R 50 /gig	5	R 250.00
2. Printing paper	Printing of institutional documents	R 0.50 per page	20	R 10.00
Personnel				
1.Editor	Language and editing	R 19 per page	30	R 570.00
<b>Grand Total</b>				<b>R 830.00</b>

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## APPENDIX 3: HREC Approval Letter



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



Room E53-46 Old Main Building  
Groote Schuur Hospital  
Observatory 7925  
Telephone [021] 406 6492  
Emails: [sumayah.ariesdien@uct.ac.za](mailto:sumayah.ariesdien@uct.ac.za)  
Website: [www.health.uct.ac.za/fhs/research/humanethics/forms](http://www.health.uct.ac.za/fhs/research/humanethics/forms)

26 October 2018

**HREC REF: 693/2018**

**Dr C Saunders**  
Division of Emergency Medicine  
c/o Vathiswa Mzamo  
F51, OMB

Dear Dr Saunders

**PROJECT TITLE: THE BURDEN OF TRAUMA MANAGED BY THE WESTERN CAPE GOVERNMENT EMERGENCY MEDICAL SERVICE: AN EPIDEMIOLOGY STUDY- (MPhil Candidate - Mr M.N. Abdullah)**

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

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

**Approval is granted for one year until the 30 October 2019.**

Please submit a progress form, using the standardised Annual Report Form if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.

(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))

***We acknowledge that the student: Mr Mohammed Abdullah will also be involved in this study.***

**Please quote the HREC REF 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

Signature Removed

**PROFESSOR M BLOCKMAN**  
**CHAIRPERSON, FHS HUMAN RESEARCH ETHICS COMMITTEE**

Federal Wide Assurance Number: FWA00001637.  
Institutional Review Board (IRB) number: IRB00001938

## APPENDIX 4: WCG EMS Approval Letter



DIRECTORATE: EMERGENCY MEDICAL SERVICES  
ENQUIRIES: Dr Shaheem de Vries  
shaheem.devries@gwc.gov.za  
+27 21 508 4523

Attention: Mr. Naseef Abdullah

**RE: THE BURDEN OF IKAUMA MANAGED BY THE WESTERN CAPE GOVERNMENT EMERGENCY MEDICAL SERVICE: AN EPIDEMIOLOGICAL STUDY**

Dear Mr. Abdullah,

Your request on the above matter refers.

I thank you for the request to conduct research within the Western Cape Government Emergency Medical Services. Your proposal has been evaluated by the Emergency Medicine Division Research Committee and has been recommended for approval by this office.

I am therefore pleased to inform you that such approval is hereby granted.

I wish you well in your endeavor and trust that you will keep this office and its department informed of your findings when these become available. I am so looking forward to the insights that your research will afford us.

Yours sincerely

**Dr Shaheem de Vries**  
Head: Emergency Medical Services  
Western Cape Government Health

Date: 4<sup>th</sup> December 2018

Signature removed

