THE IMPACT OF THE COVID-19 PANDEMIC AND VARIOUS LOCKDOWN LEVELS ON EMERGENCY MEDICAL SERVICES RESPONSE TIMES TO TRAUMA INCIDENTS IN THE WESTERN CAPE PROVINCE, SOUTH AFRICA

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DECLARATION

I, ***Omar Alrashed***, hereby declare that the work on which this dissertation/thesis is based is my original work (except where acknowledgements indicate otherwise) and that 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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Part A: Background And Literature Review

Background

The outbreak of the COVID-19 crisis presented an immense challenge to both private and public health institutions and brought to the fore the importance of emergency medical services. The COVID-19 crisis provided evidence of the importance of out-of-hospital care for the lives of the patients depending on access to prompt medical care. Emergency Medical Services (EMS) serve as the first step in accessing the healthcare system for many within South Africa and as such played a pivotal role in the continuation of initiating medical care during the COVID-19 pandemic. The importance of EMS within the healthcare system was highlighted during the pandemic due to increased pressures placed on an already overstrained healthcare system.

The initial wave of the COVID-19 pandemic had profound effects on societies and healthcare systems worldwide. Notably, the restrictions on travel and movement during the pandemic resulted in a significant reduction in traffic collisions, leading to fewer cases of physical trauma globally (1). However, reports, particularly from the United States, indicate a rise in inter-personal violence, which contributed to an increase in trauma cases [2, 3].

Injuries and trauma have long been a significant public health issue in South Africa (4). In 2019, trauma accounted for over 11% of the country's disability-adjusted life years (DALYs), making South Africa one of the countries with the highest trauma burdens globally (5). This is primarily attributed to a high incidence of road traffic accidents and interpersonal violence (5). In contrast, in Gabon, an upper-middle-income nation in Sub-Saharan Africa, injuries make up less than 9% of DALYs, while in Ghana, a lower-middle-income country, the figure is estimated to be 7.24% [5, 6].

Specifically, in South Africa, Injuries and trauma have historically presented as longstanding public health challenges with substantial impact on the population's well-being (7). To mitigate the transmission of COVID-19, stringent measures were enforced globally, including in South Africa, where restrictions on alcohol sales and movement were implemented, known factors contributing to the nation's burden of injuries (8). While numerous countries reported a reduction in trauma cases as a result of these measures, studies on their impact on the Emergency Medical System (EMS), particularly in Africa, remain limited (7). During the most stringent lockdown period, there was a notable decline of over 50% in trauma presentations, accompanied by shifts in injury mechanisms and proportions (9).

The COVID-19 pandemic has brought unprecedented challenges to healthcare systems worldwide, including Emergency Medical Services and response time. This study aimed to investigate the impact of the pandemic on EMS response times to trauma incidents in the

region. Specifically, the research aimed to compare EMS response times before and during the COVID-19 pandemic, spanning from the pre-pandemic period to the different levels of lockdown. By examining response times during these periods, the study aimed to identify any significant variations and assess the resilience of EMS systems in adapting to the challenges posed by the pandemic. This inquiry was undertaken to better understand the effectiveness of emergency healthcare provision during public health crises and informing strategies for optimizing EMS operations in similar contexts. Therefore, the study sought to shed light on the crucial role of out-of-hospital care, the significance of response times, and the impact of the COVID-19 pandemic on trauma injuries.

Given the growing significance of this issue and the efforts made to address it, it becomes essential to explore how previous studies have approached the topic. A review of the existing literature will provide deeper insights into the current knowledge, identify gaps, and guide the direction of the present study.

The Western Cape Province under the COVID-19 Crisis

Towards the end of March 2020, to limit and control the spread of the virus, the South African Government invoked the National State of Disaster and employed a risk-adjusted strategy consisting of five levels, with level 5 being the most - and level 1 the least - restrictive. In each of these levels, movement, industry, alcohol sales, and gatherings were restricted. A risk-adjusted strategy means that as COVID-19 cases increased or decreased the level of restrictions would follow. Table 1 outlines the effective dates of the different levels of lockdown that have occurred until now and the associated restrictions, which ranged from restrictions to travel and public gatherings to limitations in alcohol sales leaving the residence. Figure 1 illustrates how the lockdown level unfolded since March 2020.

Table 1: Lockdown levels and related restrictions since the end of March 2020

Lockdown	Dates Effective (2020)	Summary of Restrictions
Level 5	27 March to 30 April (30 days)	Only essential travel No interprovincial travel All non-essential commercial and industrial activities suspended Curfew 20h00 – 05h00 No public gatherings No alcohol sales
Level 4	1 May to 31 May (31 days)	Only essential travel No interprovincial travel except for special circumstances (e.g. funerals) All non-essential commercial and industrial activities suspended Curfew 20h00 – 05h00 Public gatherings limited to 50 people Restaurants open for take-away meals No alcohol sales
Level 3	1 June to 17 August (77 days) 13 July to 17 August (35 days)	Interprovincial travel for business permitted All commercial and industrial activities permitted Curfew 21h00 – 04h00 Public gatherings for worship, auctions, or funerals permitted Alcohol sales Mon to Thurs 09h00 - 17h00 No alcohol sales
Level 2	18 August to 20 September (33 days)	Most restrictions lifted Interprovincial travel permitted Most restrictions lifted Curfew 22h00 – 04h00 Any public gathering of up to 50 people Alcohol sales for off-site consumption Mon to Thurs 09h00 - 17h00
Level 1	21 September to 1 Nov 2020	All domestic travel permitted All economic activities permitted Curfew 00h00 – 04h00 Alcohol sales for off-site consumption are permitted Mondays Fridays from 09h00 until 17h00; on-site consumption Mondays to Sundays until curfew.

Figure 1: Timeline of Lockdown Levels

LITERATURE REVIEW

Introduction

The purpose of this of this Chapter is to review the published work about effects of the COVID- 19 pandemic and associated lockdown measures on EMS response times to trauma incidents. Additionally, this Chapter is intended to review the published efforts of the existing literature to elucidate the complex interplay between the COVID-19 pandemic, lockdown measures, and EMS response times to trauma incidents. Furthermore, existing literature has been sought to determine the impact of the pandemic and the related restrictions imposed in the Western Cape on the response, scene, and handover times with injured patients, epidemiology, and severity of injury presentation.

Search Strategy

The researcher conducted a search of the following electronic databases: PubMed, Google Scholar, and EbscoHOST (e.g, Africa-Wide, CINAHL, Eric, PsycINFO). The search was conducted to retrieve the published English articles between 2020-2024 that are relevant for the current study. The following keywords were used: (Trauma OR Injury) AND (Response Time OR Response Times) AND (Emergency Medical Services OR EMS) AND (COVID-19 OR COVID OR COVID-19 OR Lockdown).

To ensure alignment with the scope of the parent study and the study's specific objectives, a set of inclusion and exclusion criteria are pre- determined by the parent study: 1) All trauma incidents occurring between 1 January 2019 and 28 February 2021, in the province regardless of the place of residence of the patient (e.g., within or outside the province or the country); 2) Injuries of both intent (unintentional and intentional) and of all mechanisms (e.g. road traffic, fall, burn, poisoning) and types (e.g. wounds, fractures) were included in the sampling frame, 3) Both paediatric and adult patients were included.

Trauma and Emergency Response Times

Emergency Care consists of comprehensively structured organisations that aim to provide urgent medical care to the public during health crises (1). Many medical interventions have evidenced their effectiveness, contingent upon their timely implementation to preserve life (1). Organized Emergency Care systems are pivotal in swiftly identifying acute ailments and facilitating timely access to essential treatment, consequently saving lives and bolstering the efficiency of overarching healthcare frameworks (3).

Among the critical domains of emergency care, trauma and injury management stand out as major global public health concerns (3). While advancements in trauma care have been made in recent years, rates of morbidity and mortality remain alarmingly high (10). This burden is disproportionately heavier in low- and middle-income countries, where trauma-related incidents present a more formidable public health challenge compared to high-income nations (4). In light of these disparities, Cabral et al. (17) emphasized that improving emergency response times is not merely a matter of efficiency but is intrinsically tied to enhancing survival rates and reducing long-term morbidity in trauma patients. Therefore, the seamless coordination between prehospital trauma care and rapid EMS response is essential for maximizing the effectiveness of emergency medical systems in saving lives and improving patient outcomes.

EMS are integral to disaster operations, including responses to pandemics (6). The role of EMS personnel as first responders to biological disasters has been extensively documented (5). Cabral et al. (5) defined response time as the interval between the notification of an incident and the arrival of an ambulance at the scene, and is seen as a critical metric in EMS performance. According to (8), the benchmark for an ideal response time is less than eight minutes. It is, however, important to differentiate between desired urban and rural response time metrics, as urban areas typically aim for faster response times due to higher population density and closer proximity of resources, while rural areas might have longer benchmarks due to greater distances and fewer available ambulances (9). Further research expanded on this definition by considering secondary outcomes, including changes in other key ambulance time metrics such as the average ambulance response interval (the time from dispatch to scene arrival) and the overall out-of-service interval (the duration an ambulance is unavailable for subsequent responses) (11) .

Emergency response time is contingent upon several factors that includes the call itself as the necessary starting point, followed by an accurate description of the nature and extent of the emergency medical condition, clear communication of the location and site of the incident, road networks, ambulance location and availability of emergency resources, prioritization, and the efficiency of the operator receiving the emergency call (12).

The interplay of these factors determines the response time and to this extent, appropriate trade-offs between the factors are sought to be optimized. The sought outcome is to ensure that the response time to an emergency call is reduced as much as practical and to the best interest of the patient and investments made towards seamless communication and flexible systems [13,14].

Existing literature on medical emergency response times and patient survival rates indicates

that effective treatment of cardiac arrest in adults is maximized when the response time from collapse to cardiopulmonary resuscitation (CPR) is reduced to between four and eight minutes in urban areas (14). It is thence the most widely preferred medical response time for life threatening emergencies across many nations and medical institutions revolves around eight minutes in urban areas (14). However, there is a line of argument which seems to suggest that eight minutes may not be an adequate medical response time for some life-threatening emergencies outside of cardiac arrest (15).

While the attainment of the goal of eight minutes response time for all life-threatening medical emergencies is desirable and there seems to be a deliberate effort towards meeting this, or reducing the minutes, it is imperative to also note that it is contingent upon a myriad of factors including resource investments, geo-locations and communication (16). In light of the different response times expected for the diverse medical emergencies, with some cases requiring even fewer minutes than eight and the varying complexities associated with the emergencies, some studies now tend to divide the response times into some categories such as short (<4 min), medium (4-8 min), and long (>8 min) in an effort to enhance precision and realism in the measurement of response times (12,14).

In many low-income countries (LICs), access to emergency medical transportation, such as ambulances, remains extremely limited, with less than 1% of the population benefiting from such services (17). In Africa, advanced healthcare services are often concentrated in urban areas, leaving rural and remote communities dependent on emergency medical services (EMS) and ambulances for life-threatening conditions that require prompt medical attention (18). However, many regions lack access to such services, forcing residents to rely on private transportation in emergencies (17). This highlights the critical importance of response times, which are essential for the survival of trauma patients and those experiencing acute conditions like strokes and heart attacks.

Although response time metrics are often used in measuring the effectiveness of an EMS system, it should be noted that referral pathways and access to multidisciplinary healthcare teams also carry significance in patient outcomes [19, 20]. Although inroads have been made towards improving EMS response times through the use of tools such as Global Positioning Systems and Geographical Information Systems within Africa, there remains a paucity in comprehensive datasets that speak to resource constraints, training difficulties, demographics, and epidemiology (21).

During COVID-19, the importance of collaboration between EMS, public health entities, and incident management was highlighted as it demonstrated the importance of EMS in contributing towards preparedness efforts, maintaining service delivery in the form of patient

management and transport, as well as assisting with management of the increased pressures seen on the healthcare system during the pandemic (22). By leveraging their training and expertise, EMS personnel were able to seamlessly integrate into incident management structures, contributing to preparedness efforts and safeguarding vulnerable populations and healthcare infrastructure (6).

Impact of COVID-19 and Lockdown Measures on EMS Response Times

The COVID-19 pandemic presented a significant worldwide public health challenge, disrupting the delivery and accessibility of healthcare services. Núñez et al. explored how even nations with abundant healthcare facilities, advanced technologies, and sufficient healthcare personnel were impacted (23). Consequently, countries across all continents had to adjust their systems to ensure timely access and formulate effective responses to the pandemic.

Many countries implemented widespread physical distancing measures, commonly known as "lockdowns," in response to the COVID-19 pandemic (24). The implementation of lockdown measures in response to the COVID-19 pandemic has had a significant impact on EMS response times (24). With restrictions on movement and changes in daily activities, the demand for EMS services fluctuated, leading to variations in response times (25).

Mulyono et al. addressed the lack of studies on EMS response times during the COVID-19 pandemic in a densely populated city of a low-middle income country (LMIC). Utilizing an agent-based modelling approach and input parameters from interviews with EMS staff in Bandung city, Indonesia, the study identified factors contributing to prolonged ambulance response times. The study found that factors such as the preparation process during the pandemic, and coverage area, significantly influenced response time reduction, while traffic density and crew responsiveness had less impact (26).

Furthermore, Satty et al. assessed the impact of the COVID-19 pandemic on EMS responses in a region with a low to moderate burden of COVID-19 disease. Through a retrospective review of EMS responses from 22 urban, suburban, and rural EMS agencies in Western Pennsylvania, they aimed to analyse overall trends, response characteristics, management practices, and non-transport rates during the pandemic period compared to historical controls. Comparing data from March 15 to May 15, 2020, with corresponding periods in 2016–2019, the study revealed a 26.5% decrease in EMS responses in 2020. Despite a small increase in respiratory cases and indications of a sicker patient cohort, there was a notable rise in non-transports during the pandemic period. Regression analysis showed a significant association between the pandemic period and increased non-transport rates (27).

The findings from the above study suggest that the pandemic significantly altered EMS operations, possibly due to changes in patient behaviour or adjustments in EMS protocols to reduce infection risks (27). The results underscore the pandemic's broader impact on emergency healthcare delivery, emphasizing the need for better preparedness and response strategies to maintain essential services during public health crises.

The COVID-19 pandemic disrupted EMS operations, particularly for time-sensitive conditions. The increased delays in reaching patients during the pandemic may point to challenges such as heightened safety protocols, resource limitations, or overwhelmed healthcare systems. These disruptions are critical to understand, as they can directly affect patient outcomes (28). Highlighting these issues underscores the importance of strengthening emergency medical systems to maintain effective response times during future public health emergencies.

In Denmark, Eskol et al. compared the response times with the year before and during the pandemic. The researchers gathered data on ambulance response times, on-scene durations, and mission outcomes during the first wave of the COVID-19 pandemic in the Region of Southern Denmark. The findings showed that in comparison to the pre-pandemic year, a 10.3% decrease in call volumes were noted., leading to a proportional reduction in the total number of cases requiring the use of lights and sirens. The decrease in calls, requiring the use of lights and sirens during the pandemic, indicates that fewer emergencies required this level of urgency, although the time spent attending to patients on the scene increased.

Notably, there was an increase in on-scene times for both cases involving patients transported to the hospital (20.6 minutes compared to 18.7 minutes) and those not transported (37.4 minutes versus 30.7 minutes). Despite an increase in on-scene times noted, response times remained unaffected (29).

During the pandemic, EMS response times were found to have been affected by various factors such as changes in traffic patterns, altered demand for services, and implementation of infection control measures (26). Lockdown measures, aimed at limiting the spread of the virus, were found to have led to reduced traffic congestion, resulting in potentially faster EMS response times in some areas (29). Conversely, changes in healthcare-seeking behaviour and delays in accessing medical care may have also influenced EMS response times negatively. Additionally, the need for additional precautions, such as donning personal protective equipment (PPE) and decontaminating vehicles, may have extended EMS response times (29).

Research has extensively examined the response times of healthcare services during the COVID-19 pandemic compared to periods before the pandemic, particularly during lockdown

and restriction measures [24,26,27]. Some studies focused on understanding the initial spread of the virus, evaluating preventative health measures, and assessing COVID-19 detection strategies crucial for effective healthcare delivery. Meanwhile, other research aimed to forecast healthcare responses and predict the trajectory of the pandemic, providing valuable insights into how healthcare systems adapted to unprecedented challenges and the implications for future public health crises [30–32]. These studies collectively contribute to a better understanding of the pandemic's impact on healthcare service efficiency and preparedness.

Early analyses focused on the reactive development of protective measures in response to the rising number of COVID-19 cases [23,33]. The authors suggest that the strain placed upon the healthcare system and transportation capacity of EMS, that produce the ambulance response times of interest today, are the result of cumulative reactionary measures taken during COVID-19 incursion times (33).

Effects of COVID-19 and Lockdown on EMS Response Times in South Africa to Trauma Incidents

South Africa, characterized as a diverse and developing upper-middle-income country, faces a notable burden of trauma, which stands as one of the primary causes of mortality and morbidity among young adults (34). Mahoney et al. indicated this burden places considerable pressure on the country's public health system and impacts the socio-economic welfare of affected individuals and their families (34).

To curb the spread of COVID-19, strict measures were implemented globally, including in South Africa, where restrictions such as alcohol and movement limitations were enforced, known contributors to the country's injury burden (35). While several countries reported a decrease in trauma cases due to these restrictions, there is limited research, especially in Africa, on their impact on the EMS. Consequently, Pettke et al. conducted a retrospective observational study using data from all ambulance transports for physical trauma cases between 1 January 2019 and 28 February 2021, from the Western Cape Government EMS in South Africa (totalling 87,167 cases). During the strictest lockdown period, trauma presentations declined by over 50%, with changes observed in injury mechanisms and proportions. Notably, assaults and traffic injuries decreased while accidental and self-inflicted injuries increased (24). Although absolute numbers of these incidents declined, the proportion of these injuries in relation to all injuries showed an increase. Despite these shifts, ambulance response and on-scene times remained stable, suggesting the EMS functioned effectively

despite pandemic challenges (24). Also worth mentioning that this was likely due to the restrictions, and therefore may have allowed EMS to function effectively despite the pandemic. i.e. more restrictions on movement and alcohol sales resulted in less trauma incidences of this nature, therefore perhaps establishing a new ecosystem of sorts which allowed EMS to attend to increased number of Covid-19 and other emergencies.

Conclusion

EMS play a critical role in responding to trauma and life-threatening emergencies, emphasizing that timely interventions are essential for saving lives and minimizing long-term morbidity. Factors influencing EMS response times include communication, resource availability, and geographic location, with rural areas facing greater challenges. Studies highlight that an optimal response time for urban areas is under 8 minutes, though some emergencies may require faster intervention. The COVID-19 pandemic significantly impacted EMS operations worldwide, affecting response times due to lockdown measures, traffic changes, and infection control protocols. Research from various countries, including South Africa, underscores the pandemic's effect on EMS response efficiency and highlights the need for improved preparedness in handling future public health crises

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Part B: Manuscript in Article Format

Abstract

Background: The Pre-hospital emergency medical services (EMS) are critical for they provide on-scene care in the event of a life-threatening illness, accident, or emergency that requires the timely intervention of an EMS. The COVID-19 crisis provided evidence of the importance of out-of-hospital care for the lives of the victims depending on access to prompt medical care

Methods: A retrospective cross-sectional study was conducted for examining the response times to trauma incidents before and during the COVID-19 pandemic in the Western Cape province of South Africa. This study presents a sub-analysis of data collected from emergency medical services electronic patient records.

Results: A total of 93,818 cases were included in the analysis to examine the relationships between lockdown levels and changes in trauma response time collected between 1 January 2019 to 1 28 February 2021 (no lockdown, which was 1 January 2019 - 25 March 2020, and lockdowns five levels, which were 26 March 2020 – 28th February 2021 The mean response times across different lockdown levels show some variability. Before the lockdowns, the average response time was 20 minutes and 43 seconds. During the lockdown periods, the response times fluctuated slightly and the final Lockdown period having the shortest response time 20 minutes and 12 seconds. The statistically significant difference in the mean response times of EMS to trauma incidents before and after the COVID-19 pandemic (*P = 0.03*), and the interaction term (time-after-intervention) showed a significant positive coefficient (0.0531, p = 0.003). Overall, the response times remained consistent throughout the lockdowns, with minor increases and decreases.

Conclusion: Although the COVID-19 pandemic placed increased strain on healthcare systems globally, this study found that there were statistically significant changes in EMS response times during both the different levels of the lockdowns, as well as in comparison to that of pre-pandemic response times. What is important to note is that, although the absolute number of trauma cases decreased, the type of trauma cases seen changed. In particular, an increase in assaults were noted and may be attributed to behavioural changes subsequent to the various lockdown restrictions imposed during the pandemic. Although the study only looked at the Western Cape Province in South Africa, the large sample size has allowed for improved statistical analyses and has increased the likelihood of detecting true effects. Subsequently, the findings may be useful in informing the needs and constraints imposed on EMS response times, and better guide preparations for potential future pandemics.

Introduction

Out of hospital emergency medical care is very essential in dealing with life-threatening and acute conditions including trauma and serious illnesses, which require stabilisation or expedient transfer to the nearest hospital or health institution. Pre-hospital emergency medical services (EMS) are very critical for they provide on-scene care in the event of a life-threatening illness, accident, or emergency that requires the timely intervention of an EMS. A review of the literature on emergency health care systems reveals that substantial improvements in Pre-hospital care including on-scene treatment, use of life-saving and life-sustaining equipment along with transportation to a medical institution can result in considerable reductions in mortality rates and the magnitude of ongoing health issues (36).

The outbreak of the COVID-19 crisis presented an immense problem to both private and public health institutions and brought to the fore the importance of emergency medical services (37). The COVID-19 crisis provided evidence of the importance of out-of-hospital care for the lives of the victims depending on access to prompt medical care. As the first point of contact for many, swift and efficient EMS played a pivotal role in mitigating the impact of crises and ameliorating the health conditions of the patients. The COVID-19 crisis caused the healthcare systems to place as much attention on out-of-hospital care as on the general healthcare system (38).

In addition to the local context, evidence from elsewhere, studies underscore the importance of effective triage systems, maintaining fundamental healthcare services, and implementing infection control measures during health crises (39). During the COVID-19 pandemic, the response time for wounded patients increased significantly, impacting resource allocation, and necessitating modifications to triage procedures. Understanding these changes is vital for effective resource planning. Moreover, the severity of injury presentations was impacted, emphasizing the need for a comprehensive understanding of these shifts for better healthcare planning (24).

However, existing literature presents notable gaps, particularly in the Western Cape region. This research aims to address these gaps, providing region-specific information crucial for healthcare planning and resource allocation. This aim of this study was determine the impact of the COVID-19 pandemic and lockdown restrictions on EMS response times in the Western Cape province of South Africa. Addressing these aspects will not only contribute to academic knowledge, the study will also have practical implications for healthcare planning and resource allocation, especially in the context of the Western Cape region.

Methodology

This study employs a quantitative research design based on a retrospective cross-sectional study. The response times to incidents of trauma before and during the COVID-19 pandemic were investigated considering each of the restriction periods indicated in Figure 1. The start of the pandemic is defined as from the first day of lockdown, up until the final day of lockdown, 26th March 2020 – 28th February 2021.. The comparative data used before the pandemic is from 1st January 2019 – 25th of March 2020. This study is a sub-analysis of data from a prior UCT-approved study (787/2020) entitled: “The effect of the South African response to the COVID-19 pandemic on out-of-hospital and facility-based injury care in the Western Cape province of South Africa.”

Study Design

This study employs a quantitative research design based on a retrospective cross-sectional study. A retrospective cross-sectional study is ideal for examining the response times to trauma incidents before and during the COVID-19 pandemic. This design allows for a direct comparison of response times between the two periods, offering objective data to evaluate any changes that occurred. By defining the start and end dates of the pandemic period and the comparative period before the pandemic, the study captures the temporal context essential for understanding the pandemic's impact on response times. Consequently, this research design offers a systematic and comprehensive approach to investigating changes in response times to trauma incidents, contributing valuable insights to the study objectives.

The response times to incidents of trauma before and during the COVID-19 pandemic was investigated considering each of the restriction periods. While the study period is defined as spanning from 1st January 2019 to 28th February 2021.

The comparative data used before the pandemic is from 1st January 2019 – 25th of March 2020. The study gained approval from the relevant Human Resource and Ethics Committee as the University of Cape Town (HREC326/2024). This study is a sub-analysis of data from a prior UCT-approved study (HREC787/2020) titled: “The effect of the South African response to the COVID-19 pandemic on out-of-hospital and facility-based injury care in the Western Cape province of South Africa”. Additionally, the current study performed a sub-analysis of EMS response times. Only anonymised data and completed analyses relevant to the research question was shared with the student.

Study Setting and Population

This study is limited to the Western Cape province of South Africa. The Western Cape represents the fourth largest and third most populous of South Africa's nine provinces and has a large injury burden. It was the first province in South Africa with a large COVID-19 surge and thus represents a unique and rich opportunity for understanding the interplay between response times and the pandemic period. The study population consist of the inhabitants of the whole province as we will access data on ambulance transport from the entire province, and the public Western Cape Government EMS (WCG EMS) service has full coverage of the population.

In addition to being the first province in South Africa to experience a significant surge in COVID-19 cases, the Western Cape province boasts a diverse demographic makeup, encompassing urban centres, peri-urban areas, and rural communities. Furthermore, the Western Cape Government EMS (WCG EMS) service, with its full coverage of the province's population, ensures comprehensive access to ambulance transport data, enhancing the study's representativeness and reliability. By focusing on this dynamic and populous province, the study also contributes valuable knowledge applicable to diverse healthcare contexts within South Africa and beyond.

Inclusion and exclusion criteria

As this is a sub-analysis of an existing dataset, the inclusion and exclusion criteria are pre-determined by the parent study: 1) All trauma incidents occurring between 1 January 2019 and 28 February 2021, in the province regardless of the place of residence of the patient (e.g., within or outside the province or the country); 2) Injuries of both intent (unintentional and intentional) and of all mechanisms (e.g. road traffic, fall, burn, poisoning) and types (e.g. wounds, fractures) were included in the sampling frame, 3) Both paediatric and adult patients were included.

Data Collection and Management

This study is a sub-analysis of the existing parent study dataset that has already been collected from 1 January 2019 to 1 28th February 2021, from pre-hospital Western Cape Government Emergency Medical Services (WCG EMS) records. A sample size of 103 252 records has already been reviewed and captured on REDCap. The data extraction procedure followed guidance from Gilbert and Lowentstein (39). The study has been done with the following procedures: the training of the data collectors, case selection according to clear inclusion and exclusion criteria (indicated above), clear definitions of the variables selected

and their related categories, standardized case report forms (CRF), undertake regular quality assurance checked on a random sample of cases. Only de-identified data is shared with the student for analysis and write-up.

Data/Statistical analysis

Demographic data, gender, and age, was analysed descriptively. Average (or median) response times were calculated by subtracting the time of Computer-Aided Dispatch (CAD) call from the time of scene arrival. The data was then divided into two groups (COVID vs. No COVID), and differences in response times were analysed using an unpaired student t-test, if all assumptions were met. The data was further divided into six groups (no lockdown, which was 1 January 2019 - 25 March 2020, and lockdowns five levels, which were 26 March 2020 – 28th February 2021), and differences in response time were analysed using analysis of variance. In all instances, a p-value of 0.05 within a 95% confidence interval was considered significant. All analyses were done with IBM SPSS (40).

An interrupted time series analysis was performed to determine the impact of lockdown on EMS response times, adjusted daily injury cases and COVID-19 cases and admissions through open-accessible, archived datasets (33). Results were reported graphically and trendlines, coefficients and probability values were calculated and presented. These analyses were supported by Python, with code debugged through ChatGPT’s data analyst package (41).

Results

The study employed a comprehensive statistical approach to understand how different phases of the pandemic influenced trauma cases, and response times. Initially, descriptive statistics are used to provide a detailed overview of the sample, including demographic information and triage classifications across different lockdown levels. This descriptive analysis offered insights into the distribution and frequency of trauma incidents before and during the pandemic. Subsequently, inferential statistical methods were employed to examine the relationships between lockdown levels and changes in trauma response times. A total of 93 818 cases were included in analysis. Mechanism of injury data for this period are reported elsewhere (24).

Table 1: Descriptive Statistics of the Sample

	Pre-Covid-19	Lockdown L1	Lockdown L2	Lockdown L3	Lockdown L4	Lockdown L5
Gender, n (%)						
Male	39,039 (64.0%)	10,633 (66.5%)	2,556 (64.8%)	5,720 (65.7%)	1,307 (65.3%)	1,417 (64.8%)
Female	20,433 (33.5%)	5,299 (33.2%)	1,354 (34.3%)	2,940 (33.8%)	688 (34.4%)	761 (34.8%)
Unknown	1,526 (2.5%)	52 (0.3%)	34 (0.9%)	44 (0.5%)	6 (0.3%)	9 (0.4%)
Age, mean (SD)	31.5 (16.5)	31.5 (15.7)	31.8 (15.9)	31.5 (16.4)	30.6 (17.4)	30.8 (17.5)
Triage on Arrival, n (%)						
RED	2,692 (4.4%)	699 (4.4%)	172 (4.4%)	414 (4.8%)	85 (4.2%)	94 (4.3%)
ORANGE	10,196 (16.7%)	2,535 (15.9%)	643 (16.3%)	1,434 (16.5%)	335 (16.7%)	362 (16.6%)
YELLOW	29,820 (48.9%)	7,584 (47.4%)	1,890 (47.9%)	4,138 (47.5%)	950 (47.5%)	1,035 (47.3%)
GREEN	16,327 (26.8%)	4,725 (29.6%)	1,110 (28.1%)	2,417 (27.8%)	548 (27.4%)	627 (28.7%)
BLUE	701 (1.1%)	157 (1.0%)	59 (1.5%)	134 (1.5%)	44 (2.2%)	23 (1.1%)
Response time (Mean)	0:20:43	0:21:22	0:20:57	0:21:09	0:20:15	0:20:12

Table 1 presents a comprehensive overview of trauma incidents in the Western Cape Province, South Africa, before and during various lockdown levels of the COVID-19 pandemic. The data reveal a predominance of male patients, constituting 64.0% of the total sample, with an average age of 31.5 years. The triage categories indicate that the "YELLOW" classification consistently represents the largest proportion of cases, ranging from 47.3% during Lockdown L5 to 48.9% pre-COVID-19, suggesting a relatively stable level of urgency across lockdowns. In contrast, the percentage of "RED" triage cases remained low but stable, fluctuating between 4.4% and 4.8%, with a notable increase during Lockdown L3.

Furthermore, the mean response times across different lockdown levels show some variability. Before the lockdowns, the average response time was 20 minutes and 43 seconds. During the lockdown periods, response times generally increased, reaching 21 minutes and 22 seconds in Lockdown L1. There was a slight decrease to 20 minutes and 57 seconds in Lockdown L2 and 21 minutes and 9 seconds in Lockdown L3. The response

times continued to fluctuate slightly, with Lockdown L4 showing a decrease to 20 minutes and 15 seconds, and Lockdown L5 having the shortest response time of 20 minutes and 12 seconds. Overall, the response times remained fairly consistent throughout the lockdowns, with minor increases and decreases.

Statistical Analyses

Inferential statistics were used to analyse the differences in EMS response times to trauma incidents before and after the onset of the COVID-19 pandemic, as well as across different lockdown levels. A statistical analysis was conducted to assess these variations, using both t-tests and ANOVA to determine if significant differences existed. The t-test was employed to compare the mean response times between the pre-pandemic period and the pandemic period, revealing notable changes in EMS efficiency. Additionally, an ANOVA was conducted to analyse the response times across various lockdown levels, highlighting the impact of different restrictions on emergency response.

The t-test analysis revealed a statistically significant difference in the mean response times of EMS to trauma incidents before and after the COVID-19 pandemic ($P = 0.03$). The data indicates that the average response time increased in the pandemic period compared to the pre-pandemic period.

Additionally, the analysis using ANOVA found statistically significant differences in EMS response times across the different lockdown level groups ($p < 0.01$). This result indicates that the level of lockdown imposed had a notable effect on the efficiency of EMS in responding to trauma incidents. Response times varied significantly between the strictest lockdown levels and those with fewer restrictions.

Overall, the findings demonstrate that both the onset of the COVID-19 pandemic and the imposition of various lockdown levels have significantly influenced EMS response times to trauma incidents.

Interrupted time series analysis

The interrupted time series analysis aims to investigate the impact of the COVID-19 pandemic on emergency medical services (EMS) response times to trauma incidents in the Western Cape Province, South Africa. This analysis compares weekly aggregated mean response times before and after the onset of the pandemic, adjusting for factors such as the frequency of injury cases and the number of weekly COVID-19 admissions (Figure 1 and Table 2). By examining these variables, the study seeks to understand the extent to which the pandemic and its associated challenges have affected EMS response times, providing valuable insights

into the operational impacts of the COVID-19 crisis on emergency healthcare services. The analysis utilized an ordinary least squares (OLS) model, which was adjusted for the frequency of trauma incidents per week and the number of weekly COVID-19 admissions.

The results indicate that both time and the onset of COVID-19 significantly affected EMS response times. Specifically, the coefficient for time (0.0531, $p = 0.003$) suggests that response times increased gradually over the study period. Additionally, the intervention variable representing the onset of COVID-19 had a substantial immediate effect on response times, with a coefficient of 7.058 ($p < 0.001$), indicating a sharp increase in response times immediately following the onset of the pandemic.

Interestingly, the interaction term (time-after-intervention) also showed a significant positive coefficient (0.0531, $p = 0.003$), suggesting that the increasing trend in response times continued even after the pandemic began. This pattern implies that the challenges introduced by the pandemic had a lasting effect on EMS operations.

Conversely, the number of COVID-19 admissions had a small but statistically significant negative influence on response times (coefficient = -8.84E-06, $p = 0.018$). This result indicates that as COVID-19 admissions increased, EMS response times slightly decreased, possibly due to shifts in resource allocation or changes in demand dynamics. The frequency of trauma incidents (incident frequency) showed a non-significant negative effect on response times (coefficient = -0.0017, $p = 0.095$), suggesting that variations in the number of incidents did not significantly impact response times during the study period (See Table 2).

Regarding model performance, the overall model explained 23.9% of the variance in EMS response times (R-squared = 0.239) and was statistically significant (F-statistic = 3.869, $p = 0.0167$). The Durbin-Watson statistic of 1.711 indicates that there is minimal autocorrelation in the residuals, suggesting that the model's assumptions are reasonably met. Furthermore, the Jarque-Bera test ($p = 0.8$) suggests that the residuals are normally distributed, supporting the validity of the OLS model used for the analysis (See Table 2).

Table 2 - Result of the Interrupted Time Series Analysis

	Coefficient	Std Err	t	P>|t|
Time	0.0531	0.017	3.185	0.003
Intervention	7.058	1.072	6.584	0.0
Time_after_intervention	0.0531	0.017	3.185	0.003
Incident frequency	-0.0017	0.001	-1.713	0.095
Number of covid admissions	-8.84E-06	3.57E-06	-2.477	0.018
Model performance				
F-statistic 3.869 (p= 0.0167)				
R-squared: 0.239				
Durbin-Watson: 1.711				
Jarque-Bera (JB): 0.444 (p=0.8)				

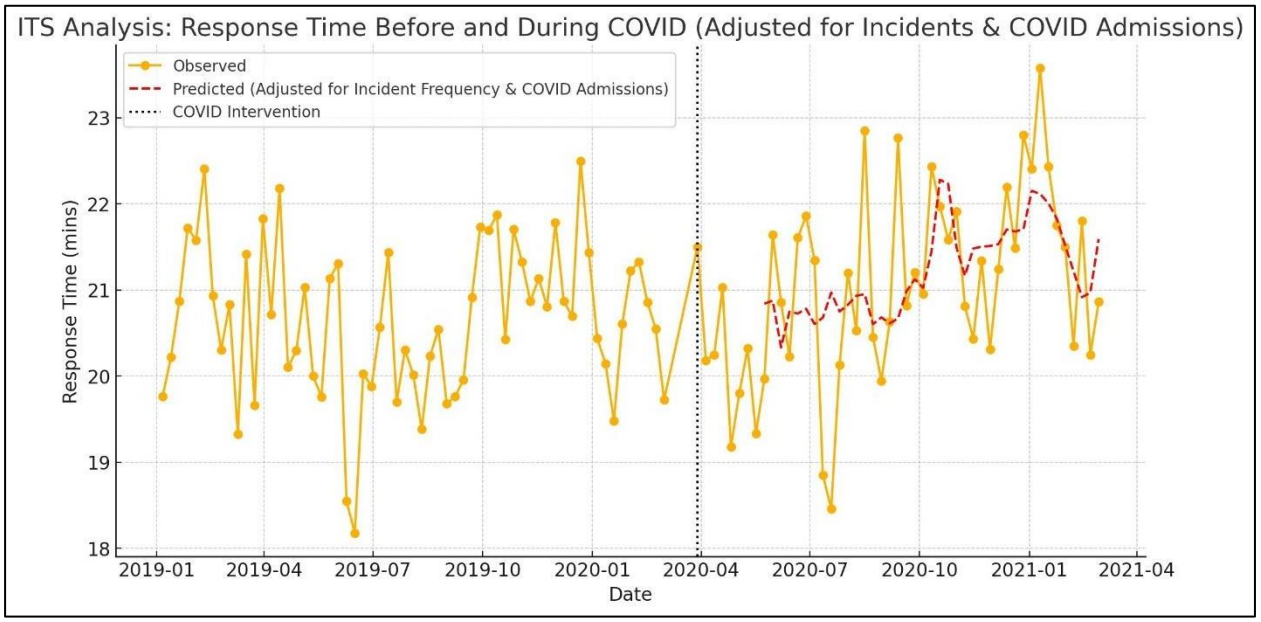

Figure 2: Response Time Before and During COVID

Discussion

This study aimed to determine the influence of the COVID-19 pandemic and different lockdown levels on the response time of emergency medical services to trauma incidents. No significant changes in triage categories were observed, however statistically significant differences in response times were found when compared to that of the pre-pandemic period. These differences, however, carry inconsequential clinical relevance.

The main result of the current study indicates that the mean response times for EMS during the COVID-19 lockdowns showed only slight variations across different lockdown levels. Despite an initial increase in response times at the onset of the lockdowns, the overall fluctuations were minimal, with the shortest response time occurring in the final lockdown stage. This suggests that, overall, the lockdown measures had a limited impact on EMS response times, and emergency services were able to maintain relatively consistent performance throughout the pandemic. It is important to note that a trend towards increased response time was observable even before the pandemic.

The slight variability in response times observed during different lockdown levels can be attributed to several factors. During the initial phase of the lockdown (Lockdown L1), increased response times could be due to adjustments in EMS operations, changes in traffic conditions, and possible hesitancy in dispatch decisions as health systems adapted to new protocols. As lockdowns progressed, the slight decrease in response times may reflect the adaptation and improved efficiency of EMS services as they adjusted to the pandemic conditions. Additionally, reduced road traffic due to stay-at-home orders could have facilitated quicker travel times for ambulances, contributing to shorter response times in later lockdown stages (Lockdown L4 and L5).

Satty et al. examined EMS responses in Western Pennsylvania and found a 26.5% decrease in EMS responses during the pandemic, with a notable increase in non-transports (27). Despite these changes in service patterns and patient characteristics, the study did not report significant delays in response times. Our findings align with this observation, as the response times in our study also showed minimal fluctuations, suggesting that EMS performance remained relatively stable despite changes in service demands and the pandemic's impact.

Another study (28) which focused on EMS processing times and the number of acute stroke patients during the pandemic, revealed an increase in emergency delays in reaching patients. Unlike this study, our findings did not show a significant increase in response delays. Instead, response times fluctuated only slightly across different lockdown stages, implying that the EMS in our study area managed to maintain relatively consistent response times, even under the pandemic's pressure.

The necessity for EMS personnel to adhere to new health guidelines, such as wearing personal protective equipment (PPE) and disinfecting equipment, may have expected to have caused delay in response times during the pandemic. However, despite the associated increase in demand on EMS during the pandemic, it could be argued that the total decrease in number of trauma responses required negated the pandemic's increase and subsequently did not impact response times to trauma cases. It is worth noting when comparing between stricter lockdown levels and the pre-pandemic period no significant changes in triage categories were observed, nor statistically significant differences in response times were found.

These findings are consistent with some previous studies while differing from others. For example, Mulyono et al. found that pandemic-specific factors, such as preparation processes and the area of coverage, significantly influenced response times (26). Their study also reported increased response times due to operational challenges faced by EMS during the pandemic. This could be due to differences in healthcare systems, pandemic management strategies, and regional challenges faced by EMS teams (28).

In comparison, Huabbangyang observed an increase in emergency delays for acute stroke patients during the pandemic (28). However, Eskol et al. reported no significant change in response times during the pandemic in Denmark, highlighting a discrepancy (29). This could be due to differences in healthcare systems, pandemic management strategies, and regional challenges faced by EMS teams (29).

Pettke et al. observed a significant decrease in trauma presentations by over 50% during the strictest lockdown periods in South Africa (24). They reported changes in the nature of injuries, with decreases in assaults and traffic-related injuries but increases in accidental and self-inflicted injuries. Despite these shifts in trauma cases, the study found that ambulance response and on-scene times remained stable. This suggests that the EMS in South Africa was able to maintain its operational efficiency despite the challenges posed by the pandemic, potentially due to reduced trauma incidents from movement and alcohol restrictions.

Additionally, another study highlighted the impact of alcohol sale restrictions on trauma cases during South Africa's lockdown. The study found that trauma cases decreased significantly during periods with complete alcohol bans compared to periods with restricted sales, demonstrating the influence of alcohol on injury rates. These findings suggest that strict alcohol restrictions were effective in reducing trauma incidents, contributing to a lower demand on EMS services during the lockdown (35). This aligns with our findings in the sense that both studies observed changes in trauma incidents due to lockdown measures. However, van

Hoving et al.'s study did not specifically address response times, focusing instead on trauma trends related to alcohol restrictions.

In this study, statistical significance indicates that the observed differences in EMS response times across various lockdown levels are unlikely to have occurred by chance ($P < 0.05$). However, clinical significance considers whether these differences have practical implications for patient care. For instance, even a statistically significant increase in response time might not translate to a meaningful impact on patient outcomes if the increase is minimal. This study found that response times changed by about one minute which is unlikely to result in clinical impact in a system that cannot prioritise traumatic cardiac arrest due to resource constraints.

The Interrupted Time Series (ITS) analysis controls for confounding variables and allows for a clearer understanding of the impact of the COVID-19 pandemic on trauma incidents and EMS response times. Adjusting for factors such as demographic variables and external influences ensures that the observed effects are attributed to the pandemic's impact. This refined analysis enhances the reliability of the findings, allowing for more accurate conclusions about how different lockdown levels influenced EMS operations.

The ITS findings show that both time and the onset of COVID-19 significantly affected EMS response times. The analysis indicated a gradual increase in response times over the study period, while the intervention for the onset of COVID-19 had a substantial immediate effect, reflecting a sharp increase in response times right after the pandemic began. Additionally, the interaction term revealed that the upward trend in response times continued even after the pandemic started. Conversely, the number of COVID-19 admissions had a small but statistically significant negative influence on response times, suggesting a slight decrease as admissions increased, while the frequency of trauma incidents showed a non-significant negative effect. Overall, the model explained a meaningful portion of the variance in response times and was statistically significant, indicating that the findings are robust.

Additionally, The large sample size in this study enhances the power of statistical analyses, increasing the likelihood of detecting true effects. However, it also raises the possibility of detecting statistically significant differences that may not be clinically relevant. This is particularly important when interpreting results, as the findings must be contextualized within the clinical setting. Larger samples can also introduce variability, highlighting the importance of careful data analysis to ensure that reported trends reflect genuine patterns in EMS response.

Conclusion

Although the COVID-19 pandemic placed increase strain on healthcare systems globally, this study found that there were no clinically significant changes in EMS response times during both the different levels of the lockdowns, as well as in comparison to that of pre-pandemic response times. Although the study only looked at the Western Cape Province in South Africa, the large sample size has allowed for improved statistical analyses and has increased the likelihood of detecting true effects. Subsequently, the findings may be useful in informing the needs and constraints imposed on EMS response times, and better guide preparations for potential future pandemics.

Limitations

During our data analysis, we encountered several limitations and potential confounding factors that may have influenced the results. One of the key challenges was that the study focused exclusively on the Western Cape region. This limited geographic scope means the findings may not be fully applicable to other regions. Another challenge was the data quality and confounding factors. To minimize the effects of these confounders, the researchers' case selection according to clear inclusion and exclusion criteria, clear definitions of the variables selected and their related categories, and standardized case report forms (CRF).

The sample size was another limitation, as the dataset was restricted to records from the Western Cape. While this provided valuable insights into that specific region, it may not reflect trends or patterns seen in other areas. For future research, expanding the study to include larger and more diverse populations will be crucial for validating these findings and ensuring they are applicable on a broader scale.

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Part C: Appendices

THE IMPACT OF THE COVID-19 PANDEMIC AND VARIOUS LOCKDOWN LEVELS ON EMERGENCY MEDICAL SERVICES RESPONSE TIMES TO TRAUMA INCIDENTS IN THE WESTERN CAPE PROVINCE, SOUTH AFRICA

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Background

Out of hospital emergency medical care is very essential in dealing with life-threatening and acute conditions including trauma and serious illnesses, which require stabilisation or expedient transfer to the nearest hospital or health institution where there would be specialized medical care provided depends largely on the speed with which the patients receive medical care in well-resourced facilities by competent medical staff. Pre-hospital emergency medical services (EMS) are very critical for they provide on-scene care in the event of a life-threatening illness, accident, or emergency that requires the timely intervention of an EMS. A review of the literature on emergency health care systems, reveals that substantial Improvements in pre-hospital care including on-scene treatment, use of life-saving and life-sustaining equipment along with transportation to a medical institution can result in considerable reductions in mortality rates and the magnitude of ongoing health issues.

The outbreak of the COVID-19 crisis presented an immense problem to both private and public health institutions and brought to the fore the importance of emergency medical services. The COVID-19 crisis provided evidence of the importance of out-of-hospital care for the lives of the victims depending on access to prompt medical care. As the first point of contact for many, swift and efficient emergency medical services (EMS) played a pivotal role in mitigating the impact of crises and ameliorating the health conditions of the patients. The COVID-19 crisis caused the healthcare systems to place as much attention on out-of-hospital care as on the general healthcare system. A study by Pettkeet al. (2023) explored the relationship between pandemic restrictions and emergency medical services (EMS) in the Western Cape (Pettke et al., 2023). Their findings highlighted a dramatic reduction of over 50% in trauma presentations during the strictest lockdown. This reduction came with a shift in injury patterns, revealing valuable insights into the dynamics of trauma during a pandemic. The temporal dimensions of trauma also unfolded, showcasing shifts in injury times, with increased incidents during the day and a reduction in weekend injury volumes.

In addition to the local context, evidence from elsewhere, such as studies during previous pandemics like H1N1 influenza, the West African Ebola outbreak, and the SARS pandemic, provides crucial insights. These studies underscore the importance of effective triage systems, maintaining fundamental healthcare services, and implementing infection control measures during health crises (Gilbert et al., 1996; Hunter et al., 2017; Zaidi et al., 2019). During the COVID-19 pandemic, the response time for wounded patients increased significantly (O'Brien et al., 2019), impacting resource allocation, and necessitating modifications to triage

procedures. Understanding these changes is vital for effective resource planning. Moreover, the severity of injury presentations was impacted, emphasizing the need for a comprehensive understanding of these shifts for better healthcare planning.

However, existing literature presents notable gaps, particularly in the Western Cape region. This research aims to address these gaps, providing region-specific information crucial for healthcare planning and resource allocation. By exploring the long-term outcomes of wounded patients during pandemics, this study seeks to contribute to a more comprehensive understanding of the impact of the pandemic on injured patient response and management.

In summary, this research seeks to shed light on the crucial role of out-of-hospital care, the significance of response times, and the impact of the COVID-19 pandemic on trauma dynamics. Addressing these aspects will not only contribute to academic knowledge, the study will also have practical implications for healthcare planning and resource allocation, especially in the context of the Western Cape region.

1.1 The Western Cape Province under the Covid-19 crisis

Towards the end of March 2020, to limit and control the spread of the virus, the South African Government invoked the National State of Disaster and employed a risk-adjusted strategy consisting of five levels, with level 5 being the most - and level 1 the least - restrictive. In each of these levels, movement, industry, alcohol sales, and gatherings were restricted. Table 1 outlines the effective dates of the different levels of lockdown that have occurred until now and the associated restrictions, which ranged from restrictions to travel and public gatherings to limitations in alcohol sales leaving the residence. Figure 1 illustrates how the lockdown level unfolded since March.

Table 1 Lockdown levels and related restrictions since the end of March 2020

Lockdown	Dates Effective (2020)	Summary of Restrictions
Level 5	27 March to 30 April (30 days)	Only essential travel No interprovincial travel All non-essential commercial and industrial activities suspended

		Curfew 20h00 – 05h00 No public gatherings No alcohol sales
Level 4	1 May to 31 May (31 days)	Only essential travel No interprovincial travel except for special circumstances (e.g. funerals) All non-essential commercial and industrial activities suspended Curfew 20h00 – 05h00 Public gatherings limited to 50 people Restaurants open for take-away meals No alcohol sales
Level 3	1 June to 17 August (77 days) 13 July to 17 August (35 days)	Interprovincial travel for business permitted All commercial and industrial activities permitted Curfew 21h00 – 04h00 Public gatherings for worship, auctions, or funerals permitted Alcohol sales Mon to Thurs 09h00 - 17h00 No alcohol sales
Level 2	18 August to 20 September (33 days)	Most restrictions lifted Interprovincial travel permitted Most restrictions lifted Curfew 22h00 – 04h00

		Any public gathering of up to 50 people Alcohol sales for off-site consumption Mon to Thurs 09h00 - 17h00
Level 1	21 September to 1 Nov 2020	All domestic travel permitted All economic activities permitted Curfew 00h00 – 04h00 Alcohol sales for off-site consumption are permitted Mondays to Fridays from 09h00 until 17h00; on-site consumption Mondays to Sundays until curfew.

Figure 1 Timeline of lockdown levels

2. Research aim

The current study aims to compare the emergency medical services (EMS) response times to incidents of trauma before and during the COVID-19 pandemic in the Western Cape, province of South Africa.

3. Research objectives

1. To describe the EMS response times to incidents of trauma in the Western Cape before the COVID-19 pandemic, as defined prior to the implementation of the first lockdown, in the Western Cape province of South Africa.

2. To describe the EMS response times to incidents of trauma in the Western Cape during the COVID-19 pandemic, as defined as during the period of the first day of lockdown to the last, in the Western Cape province of South Africa.

3. To determine whether there were statistically or clinically significant differences in response times to incidences of trauma before and during the various levels of lockdown of the COVID-19 pandemic.

4. Research questions

1. What are the EMS response times to incidents of trauma in the Western Cape before the COVID-19 pandemic in the Western Cape province of South Africa?

2. What are the EMS response times to incidents of trauma in the Western Cape during the various levels of lockdown of the COVID-19 pandemic in the Western Cape province of South Africa?

3. Are there statistical significant differences in response times to incidents of trauma before and during the COVID-19 pandemic in the Western Cape province of South Africa?

5. Methodology

This study employs a quantitative research design based on a retrospective cross-sectional study. The response times to incidents of trauma before and during the COVID-19 pandemic will be investigated considering each of the restriction periods indicated above in Figure 1. The start of the pandemic is defined as from the first day of lockdown, up until the final day of lockdown, 26th March 2020 – 1st November 2020. The comparative data used before the pandemic is from 1st January 2019 – 25th of March 2020.

This study is a sub-analysis of data from a prior UCT-approved study (787/2020) entitled: “The effect of the South African response to the COVID-19 pandemic on out-of-hospital and facility-based injury care in the Western Cape province of South Africa.”

The proposed MPhil project will perform a sub-analysis of EMS response times. Only anonymised data and completed analyses relevant to the research question will be shared with the student.

6. Study setting and population

This study is limited to the Western Cape province of South Africa. The Western Cape represents the fourth largest and third most populous of South Africa's nine provinces and has a large injury burden. It was the first province in South Africa with a large COVID-19 surge and thus represents a unique and rich opportunity for understanding the interplay between response times and patient survival rates. The study population will consist of the inhabitants of the whole province as we will access data on ambulance transport from the entire province, and the public Western Cape Government EMS (WCG EMS) service has full coverage of the population.

7. Inclusion and exclusion criteria

As this is a sub-analysis of an existing dataset, the inclusion and exclusion criteria are pre-determined by the parent study: 1) All trauma incidents occurring between 1 January 2019 and 1 November 2020, in the province regardless of the place of residence of the patient (e.g., within or outside the province or the country); 2) Injuries of both intent (unintentional and intentional) and of all mechanisms (e.g. road traffic, fall, burn, poisoning) and types (e.g. wounds, fractures) will be included in the sampling frame. 3) Both pediatric and adult patients will be included.

8. Data collection and management

This study will be a sub-analysis of the existing parent study dataset that has already been collected from 1 January 2019 to 1 November 2020, from pre-hospital Western Cape Government Emergency Medical Services (WCG EMS) records. A sample size of 103 252 records has already been reviewed and captured on REDCap. The data extraction procedure followed guidance from Gilbert and Lowentstein (Matthay et al., 2021). The study has been done with the following procedures: the training of the data collectors, case selection according to clear inclusion and exclusion criteria (indicated above), clear definitions of the variables selected and their related categories (see below), standardized case report forms (CRF), undertake regular quality assurance checked on a random sample of cases. Only de-identified data is shared with the student for analysis and write-up

9. Data/Statistical analysis

Demographic data (mechanism of injury, gender, age) will be analysed descriptively. Average (or median) response times will be calculated by subtracting the time of CAD call from the time of scene arrival. Data will then be divided into two groups (COVID vs. No COVID) and differences in response times will be analysed using an unpaired student t-test, if all

assumptions are met. Data will be divided into six further groups (no lockdown which is January 1, 2019–March 26, 2020, and lockdowns five levels which are March 27, 2020–November 1, 2020,), and differences in response time will be analysed using analysis of variance. Post-hoc tests may be performed to determine which lockdown levels carry statistically significant differences in response time. In all instances, we will consider a p-value of 0.05 within a 95% confidence interval as significant. All analyses will be done with IBM SPSS. Results will be compared to assess whether differences in the EMS response times to incidents of trauma before and during the COVID-19 pandemic.

10. Ethical considerations

The parent study already has a valid HREC (787/2020) approval and approval has already been obtained for the parent study from the Western Cape Department of Health via the National Health Research Database (NHRD). Approval was granted for waiver of informed consent. The HREC approval is in date (up to 27/02/2024). The biggest risk to participants might be breaches of confidentiality. However, this will be mitigated against by only extracting anonymised. No identifying patient, practitioner, or service information will be extracted or analysed. Finally, This study will move to data collection when due clearance has been granted from the Ethics Committee, and data extraction from the sub-study done with integrity and limitations of the sub-study and the adequacy of the data there from will be acknowledged

11. Timeline

	April 2024	May 2024	June 2024	July 2024
EMDRC				
Ethical approval				
Data Collection & Analysis				
Write-up				

12. BUDGET

Item	Description	Unit Cost	Nr of Units	**Total (R)**
Statistician	Data analysis			**4000 R**
Editor	Language editor			**2000 R**
Printing	Stationary and binding			**1500**
Total				**7,500.00**

13. Dissemination of findings

Findings of all studies will be written up and publicized in peer-reviewed journals will be sought, preferably open access. All attempts will be made to publish in a DHET-accredited journal. Findings will also be summarized and shared with the Western Cape Department of Health. Findings will also be presented at relevant local, national, and international conferences through oral and poster presentations.

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

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Observatory 7925
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14 August 2024

HREC REF: 362/2024

A/Prof Willem Stassen
Division of Emergency Medicine
Email: willem.stassen@uct.ac.za
Student: ALROMA001@myuct.ac.za

Dear A/Prof Stassen

STUDY TITLE: THE IMPACT OF THE COVID-19 PANDEMIC AND VARIOUS LOCKDOWN LEVELS ON EMERGENCY MEDICAL SERVICES RESPONSE TIMES TO TRAUMA INCIDENTS IN THE WESTERN CAPE PROVINCE, SOUTH AFRICA (SUB-STUDY – 787/2020) (MPHIL – MR OMAR ALRASHED)

Thank you for submitting your study and PI Response dated 6 August 2024 to the Faculty of Health Sciences Human Research Ethics Committee (HREC) for review and approval.

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

Approval is only granted for one year until the 30 August 2025.

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

The HREC acknowledge that the following MPHIL Degree student: Mr Omar Alrashed will also be involved in this study.

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.

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

Please quote the HREC REF number 362/2024 in all your correspondence.

Yours sincerely

PROFESSOR KOBC BLONOGAN
CHAIRPERSOSOFACULTTIOF HEALTH SCIENCES HUMAN RESEARCH ETHICS COMMITTEE

Federal Wide Assurance Number: FWA00001637. Institutional Review Board (IRB) number: IRB00001938 NHREC-registration number: REC-210208-007
This serves to confirm that the University of Cape Town Human Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRC-SA), Food and Drug Administration (FDA-USA), International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use: Good Clinical Practice (ICH GCP), South African Good Clinical Practice Guidelines (DoH 2020), based on the Association of the British Pharmaceutical Industry Guidelines (ABPI), and Declaration of Helsinki (2013) guidelines. The Human Research Ethics Committee granting this approval is in compliance with the ICH Harmonised Tripartite Guidelines E6: Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95) and FDA Code Federal Regulation Part 50, 56 and 312.

HREC REF NO. 362/2024