Injury severity in relation to seatbelt usage in Cape Town

A pilot study

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Research assignment presented in partial fulfilment of the requirements for the degree of Master of Medicine in Emergency Medicine at the Stellenbosch University

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Declaration

By submitting this thesis electronically, I declare that the entirety of the work contained therein is my own original work, that I am the authorship owner thereof (unless to the extent explicitly otherwise stated) and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

Dr Clint Hendrikse

28 April 2014

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Abstract

Introduction

Injuries and death from road traffic accidents present an enormous challenge to the South African health care system and creates a significant societal and economic burden in the country. The use of seatbelts and child restraints is one of the most important actions that can be taken to prevent injury in a road traffic accident.

Objectives

This pilot study attempted to determine seatbelt prevalence in the Cape Town Metropole and compare injury severity to seatbelt usage.

Methods

A prospective cohort design was used. All occupants involved in road traffic accidents in the Cape Town Metropole attended to by EMS Metro Rescue were included during the three month data collection period. Patients, who were admitted, were followed up and injury severity scores calculated using the Injury Severity Score. Disposition from the emergency centre and follow up after one week was compared between restrained and unrestrained occupants. A 5% level of confidence was used to determine whether differences were statistically significant and odds ratios with corresponding 95% confidence intervals were calculated as relative measure of association.

Results

A total of 107 patients were included in the pre-hospital phase. The prevalence of seatbelt usage was found to be 25.23% while only 8.3% of rear seat occupants (n = 24) were restrained. A statistically significant association was shown between seatbelt non-use and higher triage category (p=0.006; Odds Ratio (OR) = 5.39, 95% Confidence Interval (CI) 1.49 to 19.47). Trends also suggest associations between seatbelt non-use and young male occupants, as well as early morning and late night driving. A total of 50 patients were followed up during the hospital phase. There was no significant association between seatbelt usage and injury severity, yet all fatalities and seriously injured patients (Injury Severity Score >15) were unrestrained (p=0.29; OR = 0.38, 95%CI 0.019 to 7.588). Unrestrained occupants were also more likely to be admitted (p=0.002).

Discussion

Seatbelt prevalence in occupants involved in road traffic accidents was much lower than national and provincial statistical claims. The strong association between seatbelt non-use and road traffic deaths and severe injuries necessitate stricter enforcement of current seatbelt and child restraint laws to improve seatbelt compliance. The information gained from this study could assist with future research projects to possible determine causes of high risk behaviour. It will potentially aid authorities to develop and implement strategies to improve road safety.

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Definition of Terms

- **Injury**: damage to a person caused by an acute transfer of energy (mechanical / kinetic / thermal / chemical / electrical / radiation) or by a sudden absence of heat (hypothermia) or oxygen (asphyxiation, drowning).
- **Cause of death:** the disease or injury which initiated the train of morbid events leading directly to death or the circumstances of the accident or violence that produced the injury.
- **Traffic accident:** a traffic accident occurs when a vehicle collides with another vehicle, pedestrian, animal, road debris, or stationary obstruction such as a tree or utility pole.
- **Fatal accident**: accidents involving the death of persons; either immediately or subsequently as a direct result of the accident. Deaths up to six days after the date of accident are included.
- The World Bank member countries' classification system based on its gross national income per capita (1):
    - **Low income**: $1,005 or less
    - **Middle income**: $1,006 - $12,275
    - **High income**: $12,276 or more

Acronyms and abbreviations

AIDS	Acquired immune deficiency syndrome
AIS	Abbreviated injury scale
BMI	Body Mass Index
CI	Confidence interval
CODES	Crash Outcome Data Evaluation System
DALY	Disability adjusted life years
EC	Emergency centre
EMS	Emergency Medical Services
GPS	Global positioning system
HIV	Human Immunodeficiency virus
ICU	Intensive Care Unit
ISS	Injury severity score
MeSH	Medical Subject Heading
METRO	Medical Emergency Transport and Rescue
NHTSA	National Highway Traffic Safety Administration
OR	Odds ratio
PRF	Patient report form
PTSD	Post-traumatic stress syndrome
RTS	Revised Trauma Score
TRISS	Trauma Score – Injury Severity Score
WHO	World Health Organisation
ZAR	South African Rand

Chapter 1: Background

Road traffic injuries and death is a severely neglected public health problem. It is grossly underestimated and responsible for nearly 1.3 million deaths and 20-50 million injuries annually.(2)

The World Health Organization (WHO) reported approximately 16 000 deaths every day worldwide from all types of injuries; representing about 12% of the global burden of disease.(3,4) This ensures that injuries rank third of the most important causes of overall mortality, with road traffic injuries being responsible for 25% of these deaths.(3,4) Road traffic collisions cause more deaths in the world than HIV/AIDS in people aged 5 to 29 and have become the leading cause of death for people aged 15-29 years.(2) Furthermore, the WHO predicts that by 2030 road traffic collisions will increase from the 9th (in 2004) to the 5th leading cause of death, while HIV/AIDS will fall from 6th to 10th ranking.(2)

In addition to the grief and suffering they cause, road traffic collisions result in considerable economic losses to victims, their families, and nations as a whole; costing most countries 1 - 3% of their gross national product.(2)

The emergence of road traffic collisions as a significant cause of death and ill-health in Africa has been masked by two important factors: lack of good data, and the historical and continuing focus on infectious diseases.(5) In addition, even when road fatalities increased and non-fatal injuries started to consume considerable health sector resources, road traffic collisions were considered a law enforcement and transportation concern, and as a result did not attract sufficient public health scrutiny.(5) It is thus clear that road traffic injuries and death are an enormous challenge to the health care systems and it creates a significant societal and economic burden in the world.

Chapter 2: Literature review

2.1 Introduction

The benefits of restraining devices in preventing injury severity and mortality in individuals involved in road traffic accidents have been studied comprehensively in first world - and high-income countries.(1) The information gained has successfully helped these countries decrease their road traffic mortality rate.(1) The lack of data and good quality studies in developing- and middle-income countries however averts the implementation of successful road safety interventions.(6) This literature review will focus on the following themes: (a) the burden and impact of road traffic accidents; (b) prevention strategies and restraining devices; (c) the use of seatbelts, and (d) injury severity and the factors influencing it.

2.2 Search strategy

The PubMed database was searched for the following MeSH terms, keywords and phrases: “Seatbelt* AND injury severity”; “Seat belt* AND injury severity”; and “Safety belt* AND injury severity”. Only English and human related articles were included. No limitation on date of publication was set.

Official reports and statistics were obtained directly from respective websites including those from the World Health Organization (7), The Road Traffic Management Corporation (8), Statistics South Africa (9), A Decade of Action for Road Safety (2,10), and the Arrive Alive Road Safety website.(11)

Additional references from within articles and reports were also sourced.

2.3 The burden and impact of road traffic accidents

2.3.1 Global burden of road traffic deaths and injuries

The impact of road traffic injuries to the burden of injury is worldwide an emerging priority. The contribution of road traffic injuries to the global burden of disease is expected to rise to 5.1% of disability-adjusted life years (DALY's) lost by 2020 (Table 1).(12,13)

Table 1: Predicted change in rank order of DALY's for the 10 leading causes of the global burden of disease between 1990 and 2020 (4)

1990		**2020**	
Rank	**Disease or injury**	**Rank**	**Disease or injury**
1	Low respiratory infections	1	Ischaemic heart disease
2	Diarrhoeal diseases	2	Unipolar major depression
3	Perinatal conditions	3	**Road traffic injuries**
4	Unipolar major depression	4	Cerebrovascular disease
5	Ischaemic heart disease	5	Chronic obstructive pulmonary disease
6	Cerebrovascular disease	6	Lower respiratory infections
7	Tuberculosis	7	Tuberculosis
8	Measles	8	War
9	**Road traffic injuries**	9	Diarrhoeal diseases
10	Congenital abnormalities	10	HIV/AIDS

The burden of road traffic accidents is disproportionately distributed with low-to-middle-income countries being most affected.(1) The road traffic mortality rate clearly demonstrates this difference with middle income countries (20.1 per 100 000) and low income countries (18.3 per 100 000) being higher than the global rate (18 per

100 000) (Figure 1).(1) Not only do the high income countries have the lowest road traffic mortality rate (8.7 per 100 000), but they also demonstrate the biggest annual improvement of all income groups.(1) Furthermore, global road fatalities are predicted to increase with 67% by 2020; an 83% increase in low-to-middle-income countries while a 28% decrease in high-income countries are expected.(4,14)

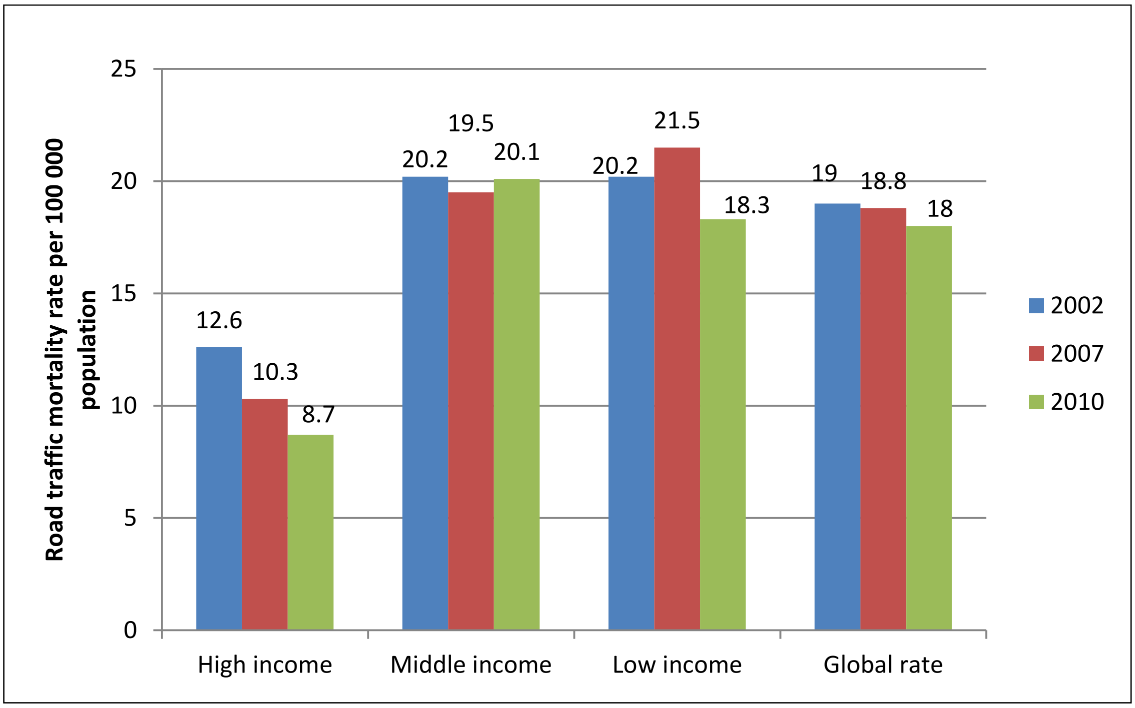

Figure 1: Road traffic mortality rate per income group (1,4,15)

The unequal burden of road traffic collisions is further highlighted when taking the population and number of registered vehicles into account. Ninety two per cent of all road traffic deaths and 96% of all children killed globally on roads occur in low-to-middle-income countries, which accounts for 84% of the world's population; but only have 53% of the world's registered vehicles (Figure 2).(1) It is evident that middle income countries are hardest hit.(1)

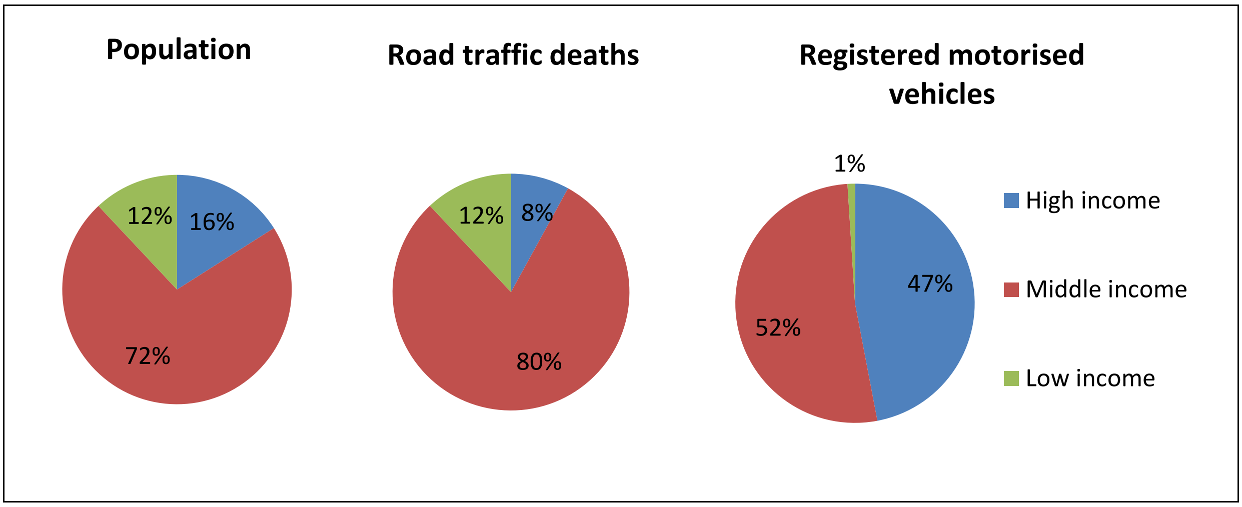

Figure 2: Population, road traffic deaths and registered motorised vehicles as percentage of global figures (1)

The morbidity related to road traffic injuries is also higher in poorer regions. Already in many low-to-middle income countries, the burden of traffic-related injuries is such that they represent between 30% and 86% of all trauma admissions.(4) Furthermore, approximately 90% of the DALYs lost due to road traffic collisions occur in low-to-middle-income countries.(4)

The African region suffers the highest road traffic mortality rate of 24.1 deaths per 100 000 population (Table 2).(1) Although Africa has only 2% of the world's vehicles, the road traffic mortality rate is well above the global average of 18.0 deaths per 100 000 population.(5) Six countries are responsible for most (64%) of the road deaths in this region: Ethiopia, Democratic Republic of Congo, Kenya, South Africa, Tanzania and Uganda.(5) Nigeria and South Africa have the highest mortality rates in the African region (33.7 and 31.9 deaths per 100 000 population per year) respectively.(5)

Table 2: Road traffic mortality rates (per 100 000 population) per WHO regions (1)

WHO Region	2010
African	24.1
Eastern Mediterranean	21.3
South-East Asia	18.5
Western Pacific	18.5
Americas	16.1
European	10.3
Global	18.0

Every year around 14 000 people die on South African roads (according to the WHO this number could be closer to 16 000).(1,16-18). Although the annual national number of road traffic deaths is decreasing slightly, it is clear that a difference exists at provincial level (Table 3, Table 4).(16-18) More than 50% of fatal road collisions occurred in only three of the eleven provinces, with the number of road traffic fatalities 2.7 times higher in the rural areas than in the urban areas.(19) Furthermore, 60.13% of all fatal crashes occurred over weekends, while 60.87% occurred between 18:00 and 06:00.(18)

Table 3: Number of fatalities per province in South Africa (16-18)

	GAU	KZN	WC	EC	FS	MP	NW	LIM	NC	RSA
2007-2008	3 137	2 439	1 622	1 652	1 095	1 742	1 214	1 398	414	14 713
2008-2009	2 507	2 772	1 483	1 464	865	1 830	1 132	1 338	315	13 707
2009-2010	2 426	2 795	1 307	1 517	1 098	1 651	1 204	1 554	370	13 923
2010-2011	2 318	2 741	1 258	1 827	1 074	1 594	1 093	1 522	376	13 802

GAU = Gauteng; KZN = Kwazulu-Natal; WC = Western Cape; EC = Eastern Cape; FS = Free State; MP = Mpumalanga; NW = North West Province; LIM = Limpopo; NC = Northern Cape; RSA = Republic of South Africa

Table 4: Number of fatalities per 100 000 population per province in South Africa (16-18)

	GAU	KZN	WC	EC	FS	MP	NW	LIM	NC	RSA
2007-2008	31.69	24.30	32.71	24.25	37.26	49.07	35.67	26.06	37.36	30.60
2008-2009	23.74	27.37	27.83	22.21	30.01	50.85	33.00	25.34	27.92	28.01
2009-2010	22.64	26.64	24.59	22.73	38.15	45.75	35.66	29.37	32.62	28.13
2010-2011	20.55	25.57	24.08	27.00	38.10	44.02	34.37	27.89	34.06	27.51

GAU = Gauteng; KZN = Kwazulu-Natal; WC = Western Cape; EC = Eastern Cape; FS = Free State; MP = Mpumalanga; NW = North West Province; LIM = Limpopo; NC = Northern Cape; RSA = Republic of South Africa

The South African age distribution of road traffic deaths is similar to global trends with 64.71% of all road traffic deaths occurring among 15-44 year olds (Figure 3).(1,18) Of note, 76.36% of all fatalities were male and 92.95% of all drivers killed were male.(18)

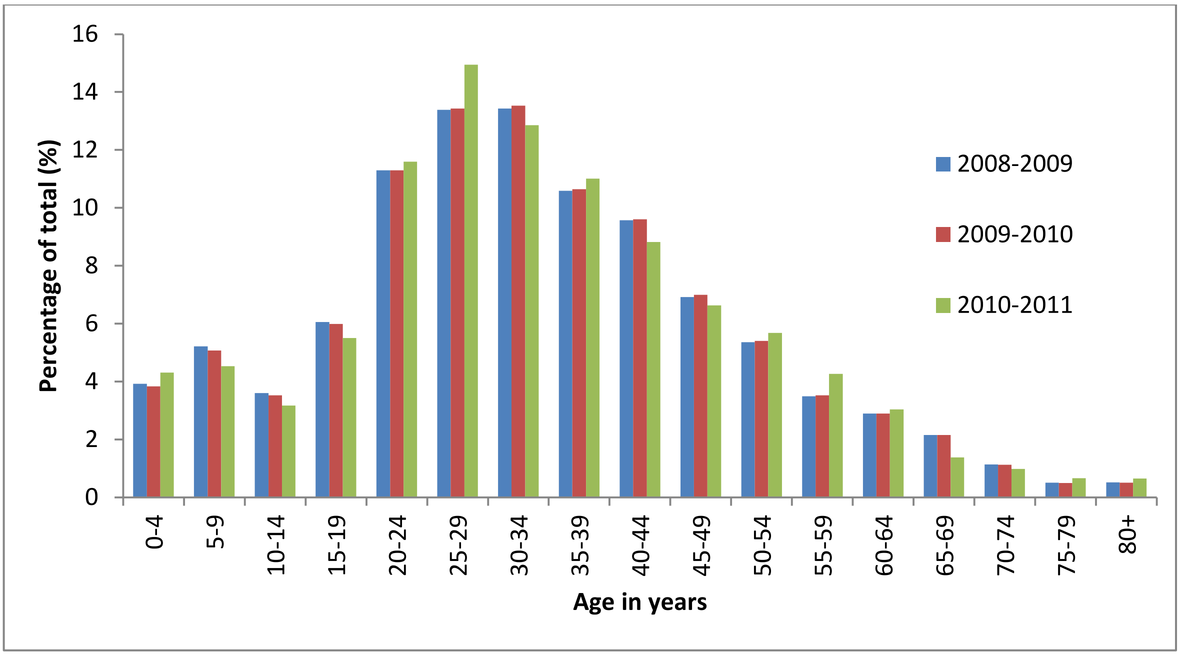

Figure 3: Age distribution of road traffic accidents in South Africa (16-18)

2.3.2 Financial impact of road traffic deaths and injuries

Road traffic fatalities and injuries create enormous social costs for individuals, families and communities, let alone the heavy burden on health systems and economy. The global cost of road traffic injuries is estimated between 1% and 2% of countries' gross national product.(15) The estimated annual costs, both direct and indirect, of traffic injuries in 15 European Union countries already exceeded €180 billion in 2004.(3) While in Africa, the estimated costs in terms of nine countries' Gross Domestic Product (GDP) varied from 1% to 9% in 2010.(5) The estimated cost of road traffic collisions in South Africa in 2002 was in the region of R42.5 billion.(20) A study of the distribution and costs of South African road traffic fatalities indicated that those living in rural areas and those aged 20-49 years are responsible for most of the attendant costs of fatal accidents and fatalities in the country.(19)

Cost figures, however, are seen as gross underestimates as the true costs of traffic collisions (taking all the long term impacts into account) are underreported.(3)

2.3.3 Long term consequences of road traffic deaths and injuries

Road traffic collisions happen in a fraction of a second but their consequences last much longer. In addition to loss of life or reduced quality of life, road traffic collisions carry many other consequences to the survivors such as legal and psychological consequences. Global and national statistics are scarce and underreported, and a true estimate of the long term impact of vehicle collisions on the occupants and national economy remain uncertain.(3)

The indirect financial cost of road traffic deaths and injuries impact both the victim and their families. More than half the people killed in road traffic accidents are young adults (aged 15 to 44 years), often the breadwinners in a family.(3) Their death subsequently leaves an enormous financial void as illustrated by the 1993 study of the European Federation of Road Victims.(3) They established that 90% of families of dead victims and 85% of families of disabled victims experienced a significant permanent decline in quality of life and/or standard of living.(3)

Parkinson et al., found that in Pietermaritzburg the majority of occupants involved in motor vehicle accidents are male (66%) and of an economically productive age (67%).(21) The estimated loss of income was significant, with average loss of workdays due to hospitalization being three weeks and for students more than 2 weeks of loss of schooling.(21)

A number of unfortunate road users involved in traffic collisions never recover fully and suffer permanent disability. A recent Spanish study concluded that 15% of survivors were treated in hospitals as in-patients; 32% were absent from work between one and three months; and 29% had remain away from work longer than three months.(3) Post-traumatic stress syndrome (PTSD) is a common but underreported effect of road accidents.(3) A large portion of literature discusses psychological residual states in the form of PTSD, but studies of social consequences are few.(3)

2.4 Prevention strategies and restraining devices

2.4.1 Prevention of road traffic deaths and injuries

The latest global status report on road safety indicates that progress has been made towards improving road safety but more rigorous and sustained action is needed to address this preventable cause of injury, disability, and death.(1) Eighty-eight countries reduced the number of deaths on their roads (1.6 million people) between 2007 and 2010; showing that improvements are possible. On the other hand, 87 countries had an increase in road traffic deaths.(1)

The *Decade of Action for Road Safety* (2011-2020) is a resolution adopted by the United Nations General Assembly in 2010.(1,10,22) The goal is to stabilise and reduce the increasing trend of road traffic fatalities, thereby aiming to save an estimated 5 million lives. Recent data indicate that there has been no overall reduction in the number of people killed on the world's roads.(1) However, the plateau should be considered in the context of a corresponding 15% increase in the global number of registered vehicles.(1)

Road traffic injuries are largely preventable. Although it is unrealistic to expect that all collisions can be prevented, it is certainly possible to implement measures to decrease serious injuries or death. Various risk factors have been identified that contribute to road traffic injuries. Excessive and inappropriate speed, impairment of drivers with drugs and alcohol, young novice drivers and seatbelt non-use are some of the main factors.(4) The “Haddon Matrix” is used to illustrate the different aspects and factors influencing road traffic collisions (Table 5).(4)

Table 5: The Haddon Matrix illustrates the different factors influencing injury severity from road traffic collisions (4)

Phase		Factors		
		Human	**Vehicles and Equipment**	**Environment**
Pre-Crash	**Crash Prevention**	Information Attitudes Impairment Police Enforcement	Roadworthiness Lighting Braking Handling Speed Management	Road Design Road Layout Speed Limits Pedestrian Facilities
Crash	**Injury Prevention During the Crash**	Use of Restraints Impairment	Occupant Restraints Other Safety Devices Crash-Protective Design	Crash-Protective Roadside Objects
Post-Crash	**Life Sustaining**	First-Aid Skill Access to Medics	Ease of Access Fire Risk	Rescue Facilities Congestion

Prevention also has positive cost implications. A 2005 cost-benefit analysis showed that investment in an enhanced seatbelt program in South Africa increased seatbelt usage rates by 16% and subsequently reduced fatalities and injuries by 9.5%. The estimated cost for such a program is ZAR 2 million per year, but the result in saved social costs is R13.6 million rand; resulting in net saving ZAR 11.6 million per annum.(23)

2.4.2 The importance of restraining devices

The use of a restraining device is one of the most important actions that can be taken to prevent injury in a motor vehicle crash.(14) Seatbelts do not prevent crashes from taking place but are secondary safety devices reducing the morbidity and mortality of vehicle occupants involved in a collision.(14) Unrestrained occupants will continue to move and subsequently collide with the vehicle's interior or other occupants at the same speed at which the vehicle was travelling before the impact.(4) This so-called "second collision" is responsible for most injuries and can be significantly reduced by the correct use of seatbelts and child restraints.(4,14) Seatbelts also distribute the forces of a crash over the strongest parts of the human body, protecting the internal organs.(14) Preventing ejection from the vehicle is another method whereby seatbelts save lives as about 75% of ejected occupants die.(14)

The effectiveness of seatbelts, when worn and correctly fitted, has been well studied. Seatbelts reduce the probability of being killed by 40-50% for drivers and front seat passengers.(24) The impact on serious injuries is almost as great, while the effect on minor injuries is smaller at 20-30%.(24) It is estimated that seatbelt use prevented about 15 200 deaths in the United States in 2004. If all passenger vehicle occupants over 4 years of age in the United States had used seatbelts that year, nearly 21 000 lives could have been saved.(25) According to the National Highway Traffic Safety Administration (NHTSA), seatbelts have saved another 75 000 lives during the 5 year period from 2004 to 2008.(25) Seatbelts used in combination with airbags is even more advantageous; decreasing injury severity and mortality rates further.(26)

Although most occupants recognize the importance of wearing seatbelts, the importance of rear seat seatbelt usage is not realized. Studies suggest that seatbelts can reduce fatalities among rear-seated car occupants by between 25% and 75%.(4,24,27) Unrestrained rear seat passengers not only pose a serious threat to their own safety, but to any occupant seated directly ahead of them.(28) Ichikawa et al., concluded that if rear seatbelts had been used, almost 80% of deaths of belted front-seat occupants could have been avoided.(28)

Anatomical differences between adults and children make typical three-point lap- and diagonal seatbelts ineffective and dangerous for use by children.(14) Appropriate child restraint systems are specifically designed to protect infants and young children from injury during a crash or sudden stop by restraining their movement away from the vehicle structure and distributing the forces of a crash over the strongest parts of the body, with minimum damage to the soft tissues.(14) Child restraints are also effective in reducing injuries in non-crash events such as a sudden stop or swerving.(14)

2.5 The use of seatbelts

2.5.1 Factors influencing seatbelt compliance

Understanding the factors that impact seatbelt use will help authorities in developing programmes that would encourage all occupants to buckle up. Knowing the profile of those who do not wear seatbelts will make it easier to target them with specific educational campaigns and programs.

Factors influencing seatbelt usage has been previously identified.(29) Most research has focused on drivers and front seat passengers, identifying age, female gender, educational level and income as the most significant factors affecting seatbelt usage.(29-34) Unfortunately, seatbelt non-users may be intrinsically unsafe drivers.(35) Factors that indicate poor driving habits also predicts seatbelt non-use and suggest that injury prevention programs should selectively target these high-risk drivers to improve seatbelt compliance (Box 1).(36) Lastly, a relationship between seatbelt usage and the occupants' body mass index (BMI) exists.(37) The strength of association increased linearly with increasing BMI categories and challenge engineers to make seatbelts more comfortable (wider, more cushioned) for overweight and obese persons.(37)

Box 1: Factors (in descending order) associated with poor seatbelt compliance in patients involved in motor vehicle collisions (36)

Drinking and driving
Youth (16-24 years)
Male sex
Speeding
Rural residence
Overnight driving
Country roads
Low level of education
Short journeys
Smoking
Having no dependants
Unemployment
Rear seat passenger

2.5.2 Seatbelt regulations

Mandatory seatbelt use has been one of the greatest success stories of road injury prevention strategies.(4,14) Seatbelt compliance has increased dramatically in countries following implementation of seatbelt legislation and campaigns, e.g. in Australia from 25% to 95%, in South Africa from 33% to 81% and in India from 0.5% to 50%.(14)

Seatbelt laws are either enforced primarily (traffic authorities allowed to stop vehicles solely for occupants being unrestrained) or secondary (traffic authorities can only fine unrestrained occupants if the vehicle is stopped for other reasons such as speeding); with a higher prevalence of seatbelt compliance associated with primary traffic laws.(38) While the vast majority of countries have legislation on mandatory seatbelt use, a number of countries do not apply these laws to front and rear seat occupants. Comprehensive seatbelt laws covering all occupants are in place for only 69% of the world's population (4.8 billion people).(14)

In South Africa, the National Road Traffic Act mandates seatbelt use.(39) The act stipulates that all motor vehicles be fitted with seatbelts and that they should be in good working order and worn at all times. However, if rear seatbelts are not fitted, the aforementioned does not apply. Although compulsory, seatbelt usage is neither strictly adhered to nor enforced, especially for passengers.(40)

2.5.3 Seatbelt prevalence

The rate of seatbelt usage varies greatly between countries and is largely influenced by the type of laws that require seatbelts to be fitted in vehicles, the laws requiring them to be used and the degree to which these laws are enforced.(14)

South Africa has one of the lowest seatbelt usage rates. According to most resources and statistics, seatbelt compliance among South Africans is between 60% and 80%.(1) In the United Kingdom, United States of America and Germany, seatbelt prevalence among front seat passengers are 96%, 84% and 98% respectively and in rear seat passengers 91%, 70% and 97% respectively.(1)

2.6 Injury Severity

The injury severity sustained by individuals in traffic accidents is influenced by a multitude of factors. Vehicle specifications; road design; driver behaviour; the individual's physiological characteristics; the angle of the collision; alcohol or substance use; as well as the use of restraint devices are all important factors.(35) It is therefore essential to quantify the relative impact of these factors on injury severity in order to identify and introduce measures to reduce (or even prevent) the severity of injuries sustained.

2.7 Motivation

The benefits of seatbelt use have been widely reported. However, the lack of good quality data from African countries affects the planning, implementing and evaluation of road safety interventions. A prospective study regarding seatbelt usage and injury severity has never been done in South Africa. The addition of emergency centre data to mortuary and traffic reports would increase the knowledge base of the effect that seatbelt non-use has on the occupants involved in road traffic collisions on Cape Town's roads. This pilot or feasibility study is designed to test the logistics and gather information prior to a larger study, in order to improve the latter's quality and efficiency. It will hopefully reveal deficiencies in the design or procedure and these can be addressed before time and resources are expended on large scale studies.

2.8 Research Question

In the event of a serious road traffic collision, to what extent does the use of seatbelts influence injury severity?

2.9 Aim

To determine the relationship between seatbelt usage and injury severity

2.10 Objectives

i. To determine the prevalence of seatbelt usage in occupants involved in road traffic collisions

ii. To determine whether the severity of injuries differs between seatbelt users and non-seatbelt users involved in road traffic collisions

Chapter 3: Methodology

3.1 Study design

This was a pilot study and in concept, a small scale preliminary study to evaluate feasibility, effectiveness of methodology, time and cost. Even though the results may not be statistically significant, this study paves the way for future studies of much bigger proportions. The minimal sample size for a population of 3 740 025 (see 3.2) with a confidence level of 95% and a confidence interval of 5, was calculated to be 384.

A prospective cohort design was used. The study had two phases:

1) A pre-hospital phase evaluating all persons involved in road traffic collisions,

2) An in-hospital phase where patients are followed up in study hospitals.

3.2 Study setting

This study took place in the City of Cape Town, a metropolitan municipality of South Africa, covering an area of 2 461 km^2.(9,41) It governs a population of 3 740 025 people in 1 068 572 households, including 129 918 informal structures in informal settlements. Vast disparities exist between wealthy communities with their first world living conditions, and poor communities with living conditions similar to the worst in developing countries. The population is predominantly Coloured (42.4%), Black African (38.6%) and White (15.7%) while the languages mostly spoken are Afrikaans (34.9%), Xhosa (29.2%), and English (27.8%). As the Western Cape's economic hub, the City of Cape Town accounts for 71.1% of the Western Cape's economy and produces 10.6% of South Africa's GDP even though 35.7% of households live below the poverty line of R3 500 income per month.(9,41) Regarding transport to work, 42.9% of people travel to work by car, 16% by taxis, 14.8% by rail, 8% by bus, 7.8% by foot and the rest by other means.(41)

The Western Cape Department of Health: Emergency Medical Services provides 24-hour medical response and pre-hospital services to the public.(42) The Emergency Medical Services (EMS) is divided into three divisions: an Ambulance service providing quality pre-hospital care and transport of patients, a Rescue service (METRO Rescue) which provides technical and medical care on a scene of a rescue operation, and Healthnet which provides non-emergency transport of patients between healthcare facilities.(42)

Although the standard operating procedure stipulates that Metro Rescue can be dispatched to any road traffic collision, they are typically called out to severe collisions or when there is a possibility of entrapped patients in the wreckage. EMS rescue technicians' primary responsibility is patient extrication and they are only involved in patient care when other emergency services are unavailable.

3.3 Injury severity scoring systems

It is unrealistic and almost impossible to accurately reduce the severity of someone's injuries to a single numeric value in order to depict their degree of critical illness. Many different injury severity scores have been described but all of them have their limitations. A good injury severity scoring system should take into account physiological and anatomical injury, as well as the patient's reserve, which is influenced by many factors including medications and ability to respond to pathological stress. Examples of typical scoring systems include the Organ Injury Scale (43-46), Revised Trauma Score (RTS (47), the Trauma Score – Injury Severity Score (TRISS) (48) and the Glasgow Coma Score (GCS) (49). The Revised Trauma Score (RTS) is a physiological scoring system that demonstrates accuracy in predicting mortality.(47) The Trauma Score – Injury Severity Score (TRISS) determines the probability of survival of a patient from the ISS and RTS using a complex formula.(48) These scores are therefore not appropriate for this study's objectives and aims.

The abbreviated injury scale (AIS) is an anatomical scoring system where injuries are ranked from 1 to 6, with 1 being minor, 5 severe and 6 a non-survivable injury (Table 6). It was first introduced in 1969 and has been updated and revised since; the latest revision being 1998.(50,51)

Table 6: The Abbreviated Injury Scale

Injury	AIS Score
Minor	1
Moderate	2
Serious	3
Severe	4
Critical	5
Non-survivable	6

The Injury Severity Score is an anatomical scoring system that extrapolates a single numerical value from multiple injuries sustained. It has a linear association with mortality and morbidity, as well as hospital stay.(50,52) Each injury is assigned a value according to the abbreviated injury scale (AIS). Only the highest AIS in each of the six body regions are used. The ISS is calculated by adding together the square of the AIS in the three most severely injured body regions. If any injury scores a 6 (non-survivable), the ISS automatically totals 75. An ISS can therefore range from 0 to 75. An example follows in Table 7.

Table 7: Example of Injury Severity Score

Region	Injury Description	AIS	Top Three Squared
Head and Neck	Cerebral Contusion	3	9
Face	No Injury	0	
Chest	Flail Chest	4	16
Abdomen	Minor Contusion Liver Complex Rupture Spleen	2 5	25
Extremity	Fractures Femur	3	
External	No Injury	0	
		Injury Severity Score	50

AIS: Abbreviated injury scale

3.4 Study population

Road traffic collisions in the Cape Town Metro pole attended to by EMS Metro Rescue during the 3 month data collection period (01 June 2012 to 31 August 2013) were eligible for inclusion.

3.4.1 Sampling

All occupants of vehicles involved in road traffic collisions were included except occupants of:

- Buses
- Taxis
- Non-motorised vehicles
- Heavy goods vehicles
- Emergency vehicles
- Two-wheel motorised vehicles (e.g. motorbikes)

Patients were followed up if they were transferred to one of the following hospitals:

- Groote Schuur Hospital
- Tygerberg Hospital
- G.F. Jooste Hospital
- New Somerset Hospital
- Victoria Hospital
- Red Cross War Memorial Children's Hospital

These hospitals include three tertiary, one regional and two district hospitals that encompass two specialised adult and one specialised paediatric trauma unit. They serve a large geographical area in the Cape Town Metropole and attend to the majority of accident victims with moderate to severe injuries. Clinics and Community Health Care Centres were excluded because most accident victims are diverted to more appropriate facilities where a higher level of care is available. Private hospitals were excluded because of logistical reasons.

This study was approved by the Stellenbosch University Health Research Ethics committee (Appendix 1), Groote Schuur Hospital (Appendix 2), Tygerberg Hospital (Appendix 3), Red Cross War Memorial Children's Hospital (Appendix 4), G.F. Jooste Hospital (Appendix 5), Victoria Hospital (Appendix 6), New Somerset Hospital (Appendix 7) and EMS management (Appendix 8).

3.5 Data collection and management

3.5.1 Pre-hospital phase

METRO Rescue completed a standardised data collection sheet (Appendix 9) for each occupant involved in a road traffic collision. METRO Rescue is not primarily responsible for patient care; therefore data was collected without impeding patient care.

Pre-hospital data collection only involved accidents that were considered to be serious. This potential selection bias can be justified by the following reasons:

- Seatbelt usage in serious accidents may decrease mortality and morbidity whereas its use in minor accidents is of lesser value.
- The group that was responsible for pre-hospital data collection (Metro Rescue) was small and easier to control, e.g. fewer incomplete or missing data. This also minimised systematic error.

Pre-hospital data collection was performed at the scene through:

- observation, e.g. witnessing occupant wearing seatbelt;
- interviews with occupants or eye witnesses, e.g. asking eye witnesses whether car rolled or approximate speed of car before impact;

- data extrapolated based on professional experience and training, e.g. assessing accident scene and damage to vehicle

The data was collected in such a way as to protect patient confidentiality. No personal or identifying information was collected for patients that were uninjured or directly discharged from the scene. Identifying information for patients transferred to hospital was captured on the pre-hospital data collection sheets. This was necessary to enable the hospital data collector to locate the patient in the relevant hospital. A research assistant collected the datasheets on a weekly basis from the Metro Rescue base.

3.5.2 In-hospital phase

The EMS patient report form (PRF) or incident number, together with the patient's name, was used as the link between pre-hospital data collection and in-hospital follow up. Patients were identified in the various trauma admission records, using the date, time and type of accident or injury. Correlating folder numbers were obtained and data were retrieved from folders. The hospital data was linked to a specific study code. Only the hospital folder number of the patient was collected. No further personal or identifying information was collected.

Patients admitted to study hospitals were followed up at one week after the admission date. Data was recorded on a standardised data collection sheet (Appendix 10). The hospital data collector was blinded to whether patients were belted or not.

Incomplete records were excluded from the data analysis process.

3.6 Data management

Data collected was entered into an electronic spread sheet (Microsoft Excel, Microsoft Corporation, Redmond, VA). The datasheet only contained the study code. A separate data file containing the identifying names, folder numbers and PRF or incident numbers were kept under lock in the offices of the Division of Emergency Medicine at Stellenbosch University. Access to this information was restricted to the principal investigator only. All data capture sheets were destroyed after data extraction – a paper shredder was used for this purpose. All electronic datasheets were password protected.

Chapter 4: Statistical Analysis

Data was analysed by the Centre for Statistical Consultation, Stellenbosch University using Statistica version 10 (2012).

Prevalence of seatbelt usage was determined and compared between different variables. A 5% level of significance was used to determine whether differences were statistically significant. In addition, significant increases in specific groups were determined by calculating odds ratios (ORs) with corresponding 95% confidence intervals (CIs).

Summary statistics were used to describe the variables and the distributions are presented with frequency tables. Medians or means were used as the measure of central location for ordinal and continuous responses. Spread was indicated by standard deviation or standard error.

The relation between two nominal variables was investigated with contingency tables and Pearson Chi-square tests.

Relationships between two continuous variables was analysed with regression analysis and the relationship measured with the Pearson correlation if they were not normally distributed.

The relationships between continuous response variables and nominal input variables were analysed using appropriate analysis of variance. Non-parametrics was used when ordinal response variables were compared to nominal input variables. For completely randomized designs, the Mann-Whitney U test was used.

Chapter 5: Results

5.1 Pre-hospital phase

METRO Rescue responded to 367 road traffic collisions during the three month study period. Data was collected on 205 patients from 55 collisions. Ninety eight patients were excluded; 96 were occupants in vehicles mentioned in the exclusion criteria and two patients sustained gunshot wounds prior to their collision. A total of 107 patients were therefore included in the pre-hospital phase consisting of 55 drivers, 28 front seat passengers and 24 rear seat occupants (Box 2).

Box 2: Patients included in the pre-hospital phase of the study

Patients identified by Metro Rescue
205

↓

Minus excluded vehicles
96

↓

Excluding patients who sustained gunshot wounds
2

↓

Total pre-hospital patients
107

5.1.1 Prevalence of seatbelt usage

A total of 19 (34.55%) drivers, 6 (21.43%) front seat passengers and 2 (8.33%) rear seat occupants were restrained (Figure 4).

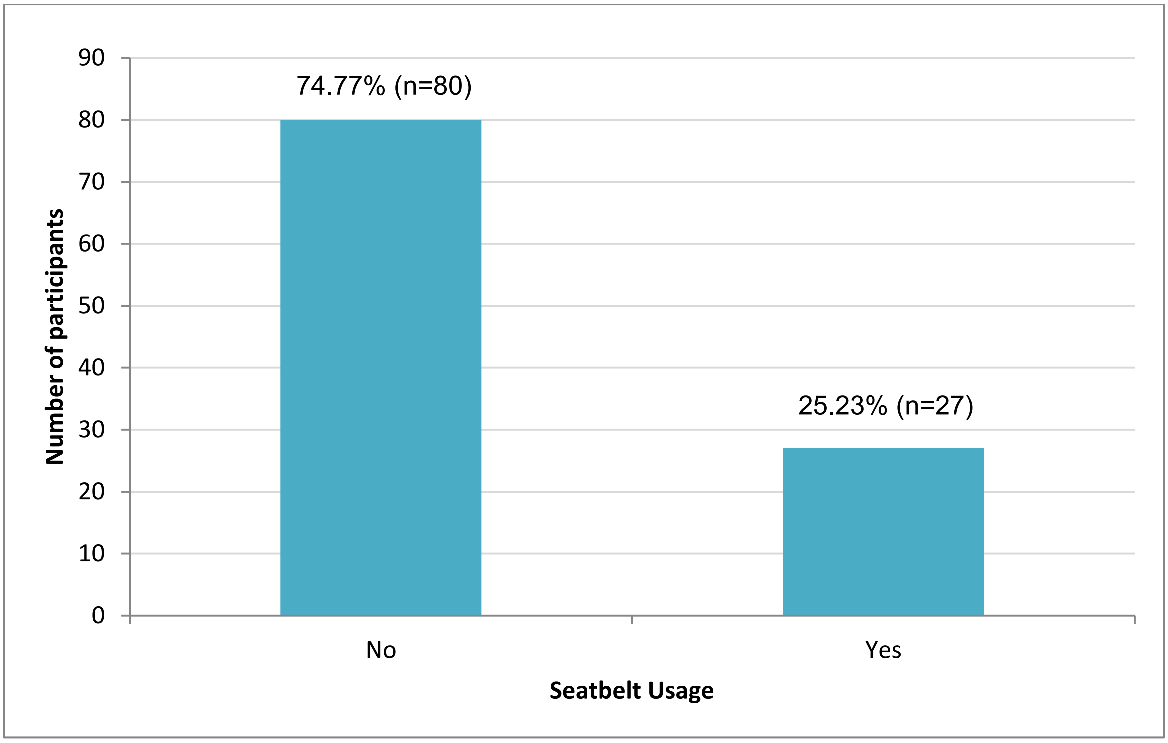

Figure 4: Prevalence of seatbelt use in occupants involved in road traffic collisions

5.1.2 Influence of age on seatbelt use

The mean age for driving with a seatbelt was 36.96 years and for driving without a seatbelt 33.41 years (p=0.23) (Figure 5). Ten occupants had incomplete data and were excluded from this part of the analysis.

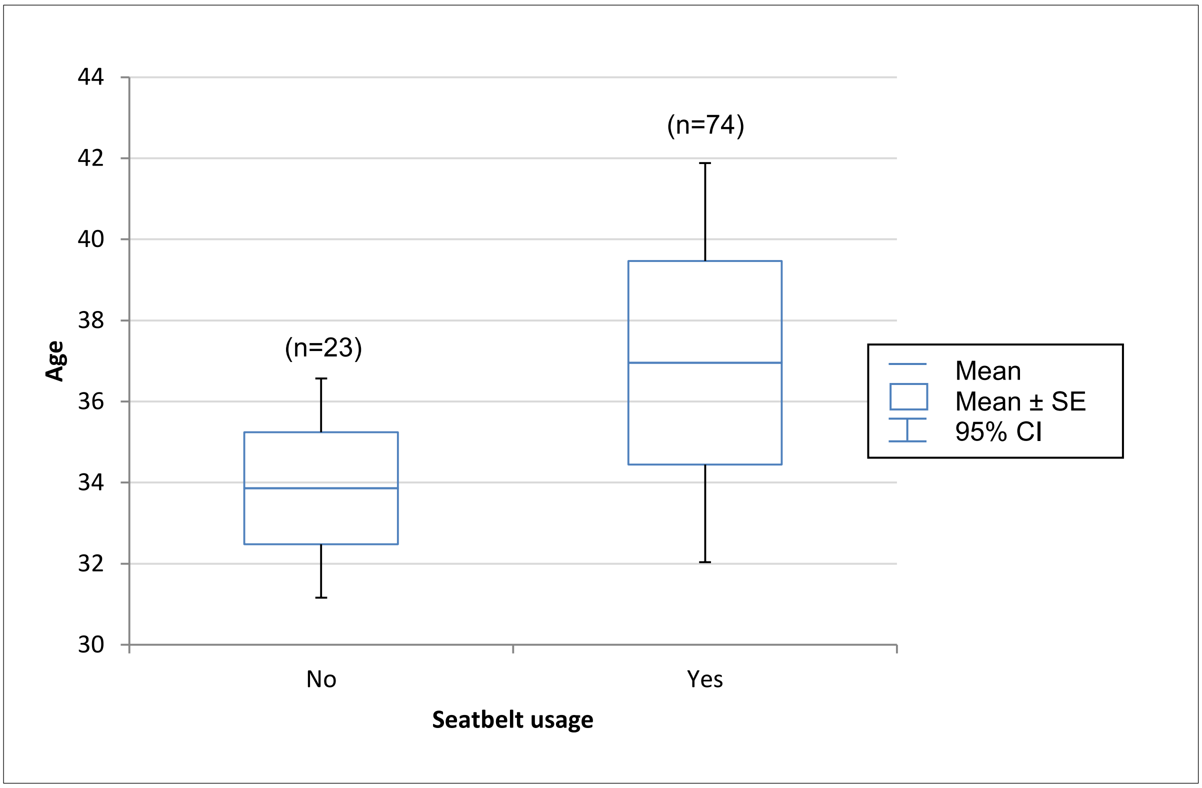

Figure 5: Seatbelt usage according to age

5.1.3 Influence of sex on seatbelt usage

Data was collected on 61 males and 45 females (one occupant had incomplete data). No statistical significant difference in seatbelt usage between men and women was noted (restrained males = 14 (22.95%); restrained females = 13 (28.89%); p = 0.49)

5.1.4 Influence of time of day on seatbelt usage

The highest seatbelt usage occurred during midday (12h00 to 16h00), with very low seatbelt usage during early morning and late night hours (p=0.13) (Figure 6). Eighteen occupants had incomplete data.

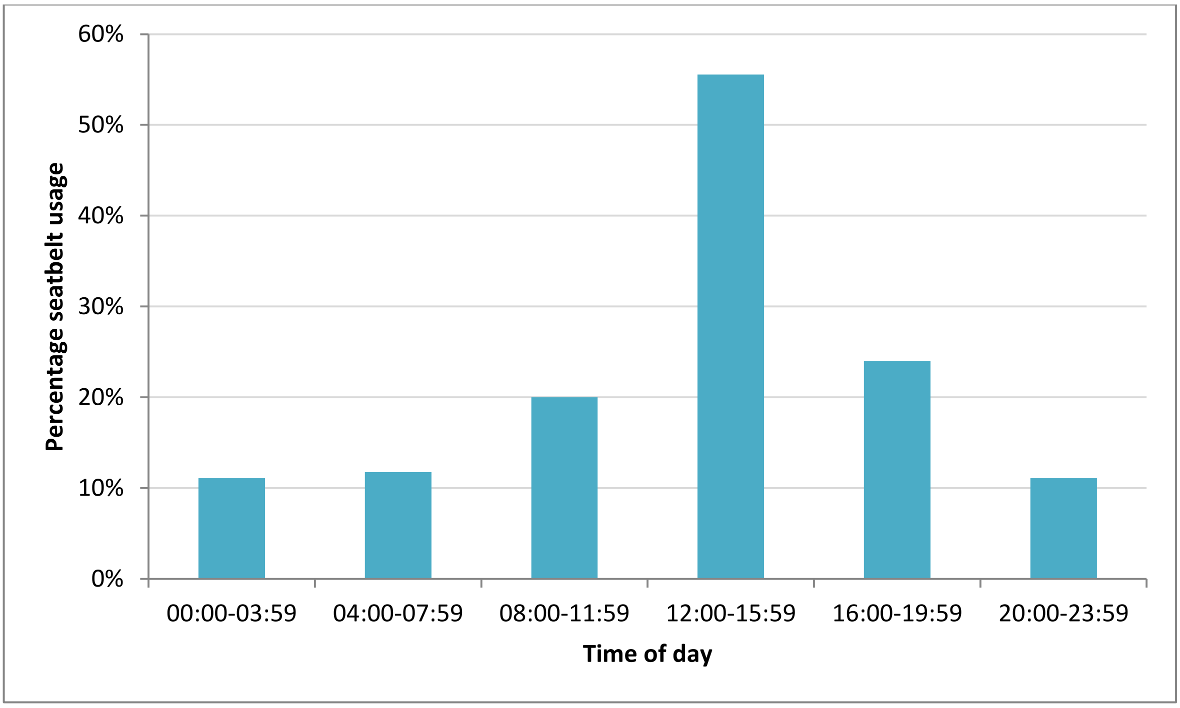

Figure 6: Influence of time of day on seatbelt usage

5.1.5 Influence of seatbelt usage on patient acuity

Pre-hospital staff prioritized patients by triaging them according to the South African Triage Scale (SATS).(39) Most patients had mild injuries (triaged green or yellow) (Table 8). A significant association between unrestrained occupants involved in road traffic collisions and triage category was demonstrated (p = 0.02).

Table 8: Influence of seatbelt usage on patient acuity

	Green	**Yellow**	**Orange**	**Red**	**Blue**
Seatbelt – No n (%)	15 (57.7%)	31 (70.5%)	10 (76.9%)	10 (100%)	11 (100%)
Seatbelt – Yes n (%)	11 (42.3%)	13 (29.5%)	3 (23.1%)	0 (0%)	0 (0%)
Total	26	44	13	10	11

Three patients had incomplete data

Patients categorised as seriously injured (triaged blue, red and orange), were significantly more likely to not have worn a seatbelt at the time of the collision (p = 0.006; OR = 5.39, 95% CI 1.49 to 19.47) (Table 9).

Table 9: Seatbelt usage in serious and non-serious injuries

	Serious injury (B/R/O)	Minor Injury (G/Y)
Seatbelt – No n (%)	31 (91.2%)	46 (66.7)
Seatbelt – Yes n (%)	3 (8.8%)	24 (34.4%)
Total	34	70

B = Blue; R = Red; O = Orange; Y = Yellow; G = Green; Three patients had incomplete data

5.1.6 Influence of seatbelt usage on disposition from pre-hospital scene

Seatbelt non-users were more likely to be transferred to hospital (p = 0.002) (Table 10). None of the patients that died on the scene (n=11) were restrained.

Table 10: Influence of seatbelt usage on disposition from pre-hospital scene

	Admitted	Discharged	Died
Seatbelt – No n (%)	64 (77.1%)	5 (38.5%)	11 (100%)
Seatbelt – Yes n (%)	19 (22.9%)	8 (61.5%)	0 (0%)
Total	83	13	11

5.1.7 Seatbelt usage and possible confounders

The association of seatbelt usage and possible confounders are depicted in Table 11.

Table 11: Association of seatbelt usage and possible confounders

	Seatbelt – No n (%)	Seatbelt – Yes n (%)	Total
Position in car (n=107)			**p = 0.12**
Driver	36 (65.5%)	19 (34.5%)	55
Front seat passenger	22 (78.6%)	6 (21.4%)	28
Rear seat behind driver	8 (100%)	0 (0%)	8
Rear seat middle	5 (100%)	0 (0%)	5
Rear seat behind front passenger	9 (81.8%)	2 (18.2%)	11
Rollover (n=98)			**p = 0.38**
Yes	26 (83.9%)	5 (16.1%)	31
No	51 (76.1%)	16 (23.9%)	67
Site of impact (n=105)			**p = 0.54**
Driver-side	23 (79.3%)	6 (20.7%)	29
Passenger-side	14 (70%)	6 (30%)	20
Front	28 (70%)	12 (30%)	40
Rear	7 (70%)	3 (30%)	10
All 4 sides	6 (100%)	0 (0%)	6
Entrapped (n=107)			**p = 0.43**
Yes	14 (82.4%)	3 (17.6%)	17
No	66 (73.3%)	24 (26.7%)	90

Incomplete data not included

5.2 In-Hospital phase

Fifty patients were followed through to the various study hospitals (Box 3). Only six hospitalised occupants were restrained.

Box 3: Patients included in the hospital phase of the study

Patients identified during pre-hospital phase
107

↓

Excluding patients discharged at scene
13

↓

Excluding patients who died on scene
11

↓

Excluding patients who were admitted to hospitals not included in study
33

↓

Total patients followed up in hospital
50

5.2.1 The influence of seatbelt usage on injury severity

The association between the ISS and seatbelt compliance was not statistically significant (p=0.67) (Figure 7). However, an association seems to exist between wearing seatbelts and lower ISS scores. The highest ISS of patients who wore seatbelts was 11. The only patient who died in hospital was unrestrained.

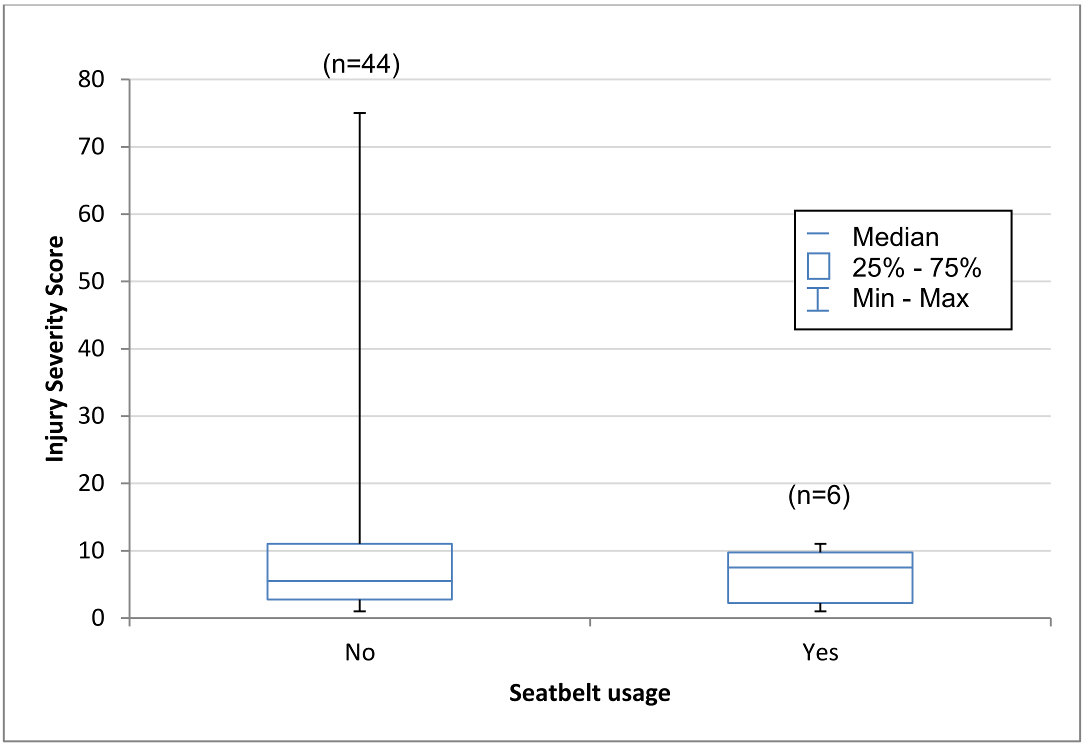

Figure 7: The influence of seatbelt usage on injury severity in hospitalized patients

The categorization of the ISS into serious (ISS>15) and less serious injuries (ISS<15) is common practice.(26,53,54) A trend towards unrestrained occupants sustaining more serious injuries was demonstrated, although not statistically significant (p=0.29; OR = 0.38, 95%CI 0.019 to 7.588) (Table 12).

Table 12: The prevention of serious injuries in hospitalized patients by seatbelt usage

	ISS < 15	**ISS > 15**
Seatbelt – No n (%)	37 (86%)	7 (100%)
Seatbelt – Yes n (%)	6 (14%)	0 (0%)
Total	43	7

ISS: Injury Severity Score

5.2.2 The influence of seatbelt usage and patient disposition from the emergency center or trauma unit

No association was shown between belted occupants and disposition from the emergency centre or trauma unit (p=0.92). No patients died in the emergency units (Table 13).

Table 13: Seatbelt usage per emergency centre disposition

	Discharged	Admitted
Seatbelt – No n (%)	23 (88.5%)	21 (87.5%)
Seatbelt – Yes n (%)	3 (11.5%)	3 (12.5%)
Total	26	24

5.2.3 The influence of seatbelt usage and patient outcome after one week

Eight patients (16%) remained in hospital after one week (Table 14). Another 15 patients were discharged and one patient died. The association between not wearing a seatbelt and increased hospital stay were not significant (p=0.93).

Table 14: Seatbelt usage per patient outcome after one week

	Discharged	Admitted	Died
Seatbelt – No n (%)	36 (87.8%)	7 (87.5%)	1 (100%)
Seatbelt – Yes n (%)	5 (12.2%)	1 (12.5%)	0 (0%)
Total	41	8	1

Chapter 6: Discussion

This study demonstrates a reduction in hospital admission rates, duration of hospital stay, injury severity and mortality rate when seatbelts are worn during road traffic accidents. Consistent with previous reports and research, these results illustrate the significance of this modifiable health risk and should motivate policy makers and government officials to enforce seatbelt laws more strictly. An in depth discussion of each variable follows.

6.1 Prevalence of seatbelt usage

The low prevalence of seatbelt usage (25%) is worrisome and considerably lower than the 60%-80% previously published.(1) Data from most of these studies were obtained from road blocks where drivers could have had enough time to belt up. This introduced a significant amount of bias that could have resulted in an over-estimation of the true seatbelt wearing rate. A recent roadside observation audit revealed a prevalence of 45% within the Cape Town Metropole.(55). Parkinson et al., conducted a prospective study analysing motor vehicle crashes in Pietermaritzburg, South Africa and found that only 17% of occupants were restrained.(21)

Our study only included patients involved in serious accidents, thus introducing a certain amount of bias in itself. Also, the small sample only included collisions that occurred in Cape Town and serviced by a small percentage of the pre-hospital work force and as a result might not be fully representative of all South Africans.

The poor seatbelt compliance of those involved in serious accidents could also suggest that unrestrained drivers are inherently unsafe drivers. Studies have shown that people involved in road traffic accidents comply with seatbelt regulations less often than those in the general public. (36) A study analysing road traffic accidents in Toronto, Canada during a one year period have found that factors indicating poor driving habits (alcohol, speeding, previous road traffic accidents and driving offences) also predicted seatbelt non-compliance.(36) Data from the Centres for Disease Control and Prevention's 2011 National Youth Risk Behaviour Survey has shown that students who engage in texting while driving were more likely to not wear their seatbelts (prevalence ratio = 1.16; 95%CI = 1.07 to 1.26).(56) These studies suggest that a subgroup of drivers exists, who may place themselves, their passengers, and other road users at risk for crash-related injuries and fatalities by engaging in multiple risky behaviours.

6.2 Influence of age on seatbelt usage

Younger drivers are less likely to wear seatbelts.(14) It is also known that the overwhelming majority of road accident fatalities occur in the 18-45 year age category (Figure 3). This study demonstrates a similar association between younger drivers not wearing seatbelts, even though not statistically significant due to the small sample size. Limited data exists with regards to factors influencing seatbelt compliance with young drivers. A study analysing data form road traffic accidents in Greece tried to determine and clarify the relationship between drivers' intentions and their behaviour regarding seatbelt compliance.(57) The factors that were positively related were "imitation", "self-protection", and "legality", while "discomfort" and "mileage" influenced seatbelt usage negatively among young drivers.(57)

A recent study in the Western Cape calculated driver mortality rates per 10 000 registered drivers in each age group and assessed the need for stricter licensing conditions for novice and younger drivers.(58) The study showed a relationship between driver's mortality risk and younger age, and suggests the need for a graduated driver licensing system to be implemented in South Africa.(58)

Contrary to the above, Cummins et al., investigated the association between age and risk of death for drivers involved in vehicle crashes and found that resilience-dependent risk of death increases with age, especially among unbelted occupants.(59) Older people (>65 years of age) are more likely to use restraining devices but have a higher mortality rate than younger people when involved in road traffic accidents.(26)

Road safety campaigns should thus target young drivers, who are responsible for most fatal accidents and have the lowest seatbelt compliance rate.

6.3 Influence of sex on seatbelt usage

This study illustrates no significant difference in seatbelt usage between the sexes, in contrast to international research demonstrating a strong female predominance for wearing seatbelts.(26,53,60) Cummins et al., analysed data from the National Trauma Data Bank of the United States of America including more than 180 000 patients involved in road traffic accidents and found males and females to be restrained in 41.8% and 51.2% of the cases.(26) An analysis of the 2002 Crash Outcome Data Evaluation System (CODES) for Wisconsin (n = 23 920) showed that 56% of males and 40% of females involved in road traffic accidents were unrestrained.(53) Our study only involved accidents that were considered to be serious, and the selection bias caused by omitting data from minor accidents could be responsible for the equal distribution of seatbelt usage among the sexes. It could also be inferred that those who do not buckle up are inherently unsafe drivers no matter the sex of the driver. An alternative explanation for the equal distribution of seatbelt usage among the sexes could be the limited sample size.

Male occupants are less inclined to wear seatbelts, despite the fact that they have the highest road traffic mortality rate.(1,15-18) Chokotho et al., calculated driver mortality rates using Western Cape Province 2008 mortuary data and found that males accounted for 80% of the deaths.(58) Data from South African road traffic accidents during 2010-2011, found that male drivers and passengers account for 92.95% and 63.04% of fatalities respectively.(18)

Male drivers are responsible for the most road accident fatalities and they have the lowest seatbelt usage rate. Road safety interventions should target this population group more efficiently.

6.4 Influence of time of day on seatbelt usage

It is evident, even within this limited sample size, that seatbelt usage decrease dramatically during night-time driving. This trend is not unique to this study as many previous studies in different countries have reported similar findings.(61-63) Factors that may influence this trend include stronger and more visible traffic officer presence during the daytime; forcing occupants to buckle up in fear of being reprimanded and fined. High risk behaviour, including alcohol intoxication and drug use at night and early mornings may influence occupants to not buckle up. Road safety campaigns and interventions usually take place during daytime and have little to no affect during night-time.(63) Chaudhary et al., conducted a study in Connecticut, United States of America, and found that the differences between night-time and daytime seatbelt usage were greater in urban areas.(62) A study in Iran involving more than 3 000 road traffic accidents concluded that time of day analysis suggested that the problem of accidents in darkness is not a matter of visibility, but a consequence of driver associated factors, including seatbelt usage.(61)

Road safety campaigns should accommodate high risk driving during night times by increasing visibility and presence of traffic officers.

6.5 The influence of seatbelt usage on triage assessment

On the scene of an accident, pre-hospital medical staff uses field triage to identify the severely injured and to determine which facility would be the most appropriate to meet the patients' needs. Field triage usually involves the assessment of vital signs, anatomy of injury, mechanism of injury, evidence of high-energy impact and other special considerations.(64) This study demonstrates a strong association (OR = 5.39) between seatbelt usage and pre-hospital triage assessment. One could argue that seatbelt usage be considered as a special consideration when doing pre-hospital field triage assessment.

Staff et al. investigated field factors that predict degree of injury in road traffic accidents and concluded that injury severity was independently predicted by several mechanical factors, including seatbelt usage. It suggests that these factors be included in pre-hospital assessment (field triage) to reduce under-triage and to help anticipate the need for high-level care.(65)

Emergency medical staff responding to a road traffic accident should regard seatbelt usage as a special consideration during field triage when deciding what level of care is necessary to meet the patients' needs.

6.6 The influence of seatbelt usage on injury severity

It is impossible to prevent all road traffic accidents but it is certainly possible to prevent subsequent serious injuries by implementing strategies to combat the various risk factors as demonstrated in the Haddon Matrix (Table 5).(4) Studies throughout the world have shown conclusively that seatbelts saves lives.(14) A review has found that seatbelts reduce the probability of being killed by 40-50% for drivers and front seat passengers and approximately 25% for rear seat occupant involved in road traffic accidents.(24) Cummins et al. analysed data from more than 180 000 patients involved in road traffic accidents in the United States of America, and found a 51% mortality reduction in the seatbelt wearing group.(26) Allen et al. analysed crash data from almost 24 000 occupants and found that 56.5% of severely injured occupants were unrestrained.(53) The odds of a severely injured being unrestrained ranged from 1.6 to 3.9 times higher than being restrained.(53)

This study found no significant association between seatbelt usage and injury severity, yet all fatalities and seriously injured patients (ISS>15) were unrestrained. This could be due to the small sample size, but the effect of other factors that could have influenced injury severity, should be considered as well (Table 5). Further research is necessary to elucidate the potential roles of these factors in low-to-middle-income countries.

High income countries, where the overwhelming majority of road safety research is being done, have better road conditions, better access to medical care, superior infrastructure and stricter enforcement of laws pertaining to road worthiness of vehicles and use of restraining devices in comparison to low- or middle income countries. Most of them have in general a more pro-active attitude towards road safety. All these factors play a role in the prevention of crashes, limiting injury severity after crashes and decreasing road traffic mortalities.

Law makers and politicians should realise the importance of seatbelts in reducing serious injuries, hospitalisation and fatalities from road accidents. The economic benefits far outweigh the costs of road safety campaigns and programmes. More emphasis should be placed on the enforcement of seatbelt laws.

6.7 The influence of seatbelt use on admission rate and length of hospital stay

The use of seatbelts reduces hospital admission rates, length of hospital stay, intensive care unit (ICU) stay and number of operations performed on patients injured in road traffic accidents.(66-69) The University of Florida Health Science Center analyzed their trauma registry data of those involved in vehicle crashes in 2003 and 2004 (n = 3426).(68) They found that unrestrained patients (n = 1682) had a significantly longer hospital length of stay (4.4 vs. 2.2 days) and increased resource consumption, as evident by increased hospital admission rate (64.9% vs. 39%).(68) Crash data from Arkansas from 2001 – 2005 (n = 4103) found that length of hospital stay was 23% longer in unrestrained patients (9.2 days vs. 7.5 days).(67)

This study showed a statistically significant increase in hospital admissions with seatbelt non-compliance. The association between length of hospital stay and seatbelt usage was not statistically significant though.

Chapter 7: Limitations

7.1 Overall process

This is a pilot study and data collection was done for a three month period only and not until a specific sample size was reached. This resulted in a small sample size with limited statistical inference.

7.2 Pre-hospital phase

Metro Rescue collected data from only 15% of the accidents they attended to during the three month data collection period. This sampling selection bias does not however influence the internal validity of the study, as the data was collected indiscriminately.

Pre-hospital data collection only involved accidents that were considered to be serious. This most likely resulted in a selection bias, where the sample population is more severely injured than the average population involved in road traffic accidents. Because seatbelts and other restraining devices are more effective during high energy transfers (serious accidents), the selection bias could overestimate the effect of seatbelts. It can be justified by the following reasons:

- Seatbelt usage in serious accidents may decrease mortality and morbidity whereas its use in minor accidents is of lesser value.
- The group that was responsible for pre-hospital data collection (Metro Rescue) was small and easier to control, e.g. fewer incomplete or missing data. This also minimised systematic error.

It is possible that occupants, especially those with minor injuries, could have exited their vehicles before Metro Rescue's arrival on the scene. This could potentially have caused a measurement bias regarding whether they were restrained or not, resulting in an overestimate of the effect of seatbelts. Metro Rescue is however called out to mostly serious injuries where extrication is necessary and this bias is therefore negligible.

7.3 Seatbelt usage

The study does not specify whether seatbelts were in working condition, fitted properly or used appropriately.

7.4 In-hospital phase

In-hospital data collection was sourced from hospital records and folders. Missing variables were common and could have influenced the study's results. However, it would have affected both groups being compared with the same probability. This non-differential error could result in an underestimation of the effect of seatbelt usage. The PRF number was used to track patients throughout the data collection process resulting in short follow up times and thereby reducing loss to follow-up significantly. The likelihood of loss to follow-up was similar in both the exposed and unexposed groups, minimising the possible effect it has on the estimate of association.

Miscalculation of the ISS could also have resulted in either under- or over-estimation of the severity of injuries. This potential error was overcome with adequate training of the data collector and periodic monitoring and cross-checking of the results by the principal investigator. This reduced the risk of misclassification.

Patients were also followed up only if they were admitted to certain hospitals. The exclusion of the patients admitted to other hospitals limits the sample size and could have an impact on the validity and accuracy of the results.

Chapter 8: Recommendations

This pilot study revealed many challenges that should be addressed in order to improve the quality and efficiency of a larger follow-up study. The data collection process was the most problematic and is therefore discussed in depth below.

8.1 Pre-hospital phase

EMS Metro collected data on only 15% of the accidents in the allocated three months, despite adequate training and continuous motivation. Multiple factors, as discussed below, could have contributed to the ineffective data collection and a detailed interview with EMS Metro could help delineate and improve their performance.

Lack of motivation

A lack of motivation was evident throughout the pre-hospital data collection period. Data collection was seen as extra work without any benefits. This could be overcome by incentives, be it monetary, moral or non-financial rewards. Incentives usually improve performance in those tasks where creativity is not required – such as in this case. Our data coordinator made use of sweet treats to reward and motivate the data collectors, resulting in temporary improvements in their performance. A feeling of being part of the project and of playing an important role in the study should be instilled among the data collectors (EMS Metro) as this would also boost morale and performance. This could be achieved by involving them in project discussions and giving feedback regularly.

Difficult paper trail

It is difficult to keep an effective and accurate paper trail in out-of-office situations. Working in cramped spaces such as in rescue vehicles and wearing heavy rescue and safety attire, could overburden the data collection process. Electronic data collection could be more practical and user friendly. An easy to use application on electronic devices, e.g. smart phones or tablets, would require only a few clicks, minimising time and effort. Another advantage of electronic data capturing includes the automatic capturing of date, time, user data, exact GPS position and weather conditions. It is well known that electronic data collection saves time, resources and boosts working morale and performance. The costs of such devices and applications should be weighed up against the benefits over paper records.

High workload and staff shortages

EMS rescue technicians were chosen to do the data collection because their primary responsibility is patient extrication and they are only involved in patient care when other emergency services are unavailable. Theoretically they should have enough time to complete the questionnaire but staff shortages and the high workload could have deterred them from doing so. Every effort should therefore be taken to minimise the time and effort it requires to complete the questionnaire.

Extensive questionnaire

The amount of detail and information captured on a data collection sheet or questionnaire is directly proportional to the potential statistical inference of a study but inversely proportional to the motivation and performance of the data collector. A data collection sheet should be simple and easy to complete and should require no more than a few seconds. This is especially applicable to fast paced, high adrenaline situations like those experienced by rescue paramedics. A balance should be found between the quantity of information required and the time and effort it will take to retrieve it. The fact that we received numerous incomplete data sheets may suggest that the process was too time consuming.

Our data collection sheet made use of tick boxes which simplified data collection and minimised time and effort required to complete it. The two open ended questions however, about the make and model of vehicle involved, received a multitude of different entries. This data was subsequently not used in the analysis process as it was difficult to categorise it into useful groups. More specific questions with tick box responses should be used in this case, e.g. sedan, hatchback or sport utility vehicle.

Other fields to consider include ejection out of vehicle, location of accident (suburb, freeway, intersection, etc.), and details of location (country or urban, rural or city, etc.).

In addition to the ‘yes’ and ‘no’ options regarding seatbelt usage on the pre-hospital questionnaire, it may be advisable to include an ‘unknown’ category.

Data collection process

Pre-hospital data collection was done by rescue paramedics after extricating and stabilising accident victims. Data was captured on paper and was collected by the study coordinator regularly. This process revealed many difficulties as mentioned and alternative methods should be considered. One option would be to have an independent data collector present at all times. Even though this would solve most data capturing difficulties, limited space on rescue vehicles would make this option impractical and the cost of three to four data collector salaries would probably outweigh the benefits of having them. A second alternative would implicate Metro Control, the central command station. This method requires the rescue paramedics to radio details of accidents to Metro Control, who captures it on their behalf. This process could ensure that all accidents are included, as Metro Control would prompt for the missing information when required. This process also has the benefit of not requiring EMS Metro to complete any forms or carry any resources with them. The benefits are obvious but involving Metro Control could be seen as a liability and a hindrance to complete their duties. The reality is that most detail about accident scenes and patients involved is already relayed to Metro Control.

8.2 In-hospital phase

Copies of patient report forms containing PRF numbers were placed in each patient's hospital folder. The names of those being followed up in hospital were also documented on the pre-hospital data collection sheets. These two variables (name of patient and PRF number) were used to track patients from the pre-hospital scene to the hospital where they were being followed up. Incomplete pre-hospital data collection sheets and missing patient report forms however made this process very challenging. In such cases, hospital and departmental records were turned to, which required much more time and effort than was initially anticipated.

A possible solution to this problem could be to involve the administrative staff of the various hospitals with the data collection process. If the patient report forms of accident victims are flagged by pre-hospital staff, administrative staff could keep a separate list, making it easier to locate the patient and his/her folder. Teamwork between pre-hospital staff and hospital administrative staff is crucial in realising this project on a bigger scale.

The difficulties that we encountered were not unique to our research project. It echoes the ongoing problems developing nations face with producing good quality studies, namely limited resources and poor record keeping (data management). In a low resource setting such as this, it is unrealistic to expect the support of multiple data collectors, electronic data collection devices, financial incentives, etc. and one would often have to make do with what is available. Despite these challenges, our study managed to produce an excellent model for future large scale research projects.

Chapter 9: Conclusion

This was a pilot study and in concept, a small scale preliminary study to evaluate feasibility, effectiveness of methodology, time and cost. In general, the results may not be statistically significant but this study paves the way for future studies of much bigger proportions.

Injuries and death from road traffic collisions presents an enormous burden on our health system and economic welfare. Its impact is underestimated and getting worse, creating a bleak outlook on our economic future.

Despite various campaigns and programs aiming to improve seatbelt compliance and road safety, road fatalities are not decreasing at an acceptable rate. More needs to be done to convince political leaders, police authorities, individual drivers and passengers that seatbelts provide essential protection from injury and can reduce the mortality and morbidity of patients involved in road traffic collisions. Comprehensive programmes of legislation, law enforcement, public education and publicity are needed to promote the benefits of seat-belt and child restraint use and to ensure compliance once legislation is in place.(14)

Studies suggest that a subgroup of drivers exist, who place themselves, their passengers, and other road users at risk for crash-related injuries and fatalities by engaging in multiple risky behaviours. It could be inferred from these studies that those who do not routinely buckle up are inherently unsafe drivers.

It is also imperative to realise that road traffic safety is not a law enforcement and transportation issue alone. Health workers and citizens should get involved and play a much bigger role in road traffic safety.

Prevention is key. It has been proven that money saved from less road fatalities due to action plans, like awareness programmes, etc., far outweighs the costs of such programmes. The crucial factor is to convince authorities and sponsors with tangible evidence and good quality data.

This study showed a strong association between seatbelt non-use and road traffic deaths and severe injuries. It also indicated that seatbelt prevalence was very low, especially in rear seat occupants. Seatbelt legislation does not improve seatbelt compliance without strong enforcement thereof. Stricter enforcement of current laws is therefore necessary to improve seatbelt compliance.

The information gained from this study could assist with future research projects to determine causes of high risk behaviour. It will hopefully aid authorities to develop and implement strategies to improve road safety.

References

(1) Toroyan T, Iaych K, Peden M. Global status report on road safety 2013: Supporting a decade of action. Available at: http://www.who.int/violence_injury_prevention/road_safety_status/2013/report/en/ Accessed on: 22 March 2013.

(2) World Health Organization. Decade of Action for Road Safety 2011–2020. Available at: http://www.arrivealive.co.za/pages.aspx?i=2959 Accessed on: 22 March 2013; Official Website: http://www.who.int/roadsafety/decade_of_action/en/ Accessed on: 22 March 2013.

(3) Elvik MR, Ortenwall MP, Mackay MM, Pelckmans MJ, Monclus MJ, Tecl MJ, et al. Social and economic consequences of road traffic injury in Europe, 2007. Available at: http://www.etsc.eu/documents.php?did= Accessed on: 22 March 2013.

(4) Peden M, Scurfield R, Sleet D, Mohan D, Hyder AA, Jarawan E, et al. World report on traffic injury prevention, 2004. Available at: http://www.who.int/violence_injury_prevention/publications/road_traffic/world_report/en/ Accessed on: 22 March 2013.

(5) World Health Organization. Status Report On Road Safety in Countries of the African Region, Brazzaville, World Health Organization, Regional Office for Africa, 2010. Available at: http://www.afro.who.int/en/clusters-a-programmes/dpc/mental-health-violence-and-injuries/features/2846-status-report-on-road-safety-in-countries-of-the-who-african-region.html. Accessed on: 22 March 2013.

(6) Samuel JC, Sankhulani E, Qureshi JS, Baloyi P, Thupi C, Lee CN, et al. Under-reporting of road traffic mortality in developing countries: application of a capture-recapture statistical model to refine mortality estimates. PloS one 2012;7(2):e31091.

(7) The World Health Organization: Data and Statistics: Injuries and Violence: Road Safety Reports, 2013. Available at: http://apps.who.int/gho/data/node.main.A989?lang=en Accessed on: 22 March 2013.

(8) Road Traffic Management Corporation. Annual Reports (2009-2013). Available at: http://www.rtmc.co.za/index.php/reports Accessed on: 22 March 2013.

(9) Statistics South Africa. Census 2011. Available at: https://www.statssa.gov.za/publications/Census%202011_data_supplied_to_National_Treasury.asp Accessed on: 22 March 2013.

(10) Road Safety Fund (UN Decade of Action). Available at: http://www.roadsafetyfund.org/Pages/default.aspx. Accessed October 25, 2013.

(11) Arrive Alive Accident Crash Statistics. Available at: http://www.arrivealive.co.za/pages.aspx?i=2826&page=Accident-Crash-Statistics. Accessed October 25, 2013.

(12) Murray CJL, Lopez AD. Alternative projections of mortality and disability by cause 1990-2020: Global Burden of Disease Study. Lancet 1997;349(9064):1498-1504.

(13) Murray CJ, Lopez AD. The Global Burden of Disease, Vol. 1 of Global Burden of Disease and Injury Series. Boston: Havard university school of public health 1996:52-110.

(14) Seat-belts and child restraints: a road safety manual for decision-makers and practitioners. London, FIA Foundation for the Automobile and Society, 2009 Available at: http://whqlibdoc.who.int/road_safety/2009/9780956140302_eng.pdf?ua=1. Accessed 22 March 2013

(15) World Health Organization. Global status report on road safety: time for action, 2009, World Health Organization: Geneva 2010. Available at: http://www.who.int/violence_injury_prevention/road_safety_status/2009/en/ Accessed on: 22 March 2013.

(16) Road Traffic Management Corporation. Annual Report, 2008/2009. Available at: http://www.rtmc.co.za/index.php/reports/annual-reports Accessed on: 22 March 2013.

(17) Road Traffic Management Corporation. Annual Report, 2009/2010. Available at: http://www.rtmc.co.za/index.php/reports/annual-reports Accessed on: 22 March 2013.

(18) Road Traffic Management Corporation. Annual Report 2010/2011. Available at: http://www.rtmc.co.za/index.php/reports/annual-reports Accessed on: 22 March 2013.

(19) Olukoga A, Harris G. Field Data: Distributions and Costs of Road-Traffic Fatalities in South Africa. Traffic injury prevention 2006;7(4):400-402.

(20) Myers J, Naledi T, Corrigall J. Western Cape burden of disease reduction project: final report. 2007. Overview and Executive Summaries June 2007;Overview of the report: Volume 1 & Executive Summaries: Volume 2-7:1-103.

(21) Parkinson F, Kent S, Aldous C, Oosthuizen G, Clarke D. Road traffic crashes in South Africa: the burden of injury to a regional trauma centre. S Afr Med J 2013 Sep 30;103(11):850-852.

(22) World Health Organization: Decade of Action. Available at: http://www.who.int/roadsafety/decade_of_action/en/. Accessed October 25, 2013.

(23) Harris G, Olukoga I. A cost benefit analysis of an enhanced seat belt enforcement program in South Africa. Inj Prev 2005;11(2):102-105.

(24) Elvik R, Vaa T, Erke A, Sorensen M. The handbook of road safety measures. : Emerald Group Publishing; 2009.

(25) National Highway Traffic Safety Administration, 2005. The national initiative for increasing safety belt use : Buckle Up America campaign. Available at: http://static2.docstoccdn.com/docs/7126085/The-National-Initiative-for-Increasing-Safety-Belt-Use-Buckle Accessed on: 22 March 2013.

(26) Cummins JS, Koval KJ, Cantu RV, Spratt KF. Do seat belts and air bags reduce mortality and injury severity after car accidents? Am J Orthop (Belle Mead NJ) 2011;40(3):E26-9.

(27) Zhu M, Hardman SB, Cook LJ. Backseat safety belt use and crash outcome. J Safety Res 2005;36(5):505-507.

(28) Ichikawa M, Nakahara S, Wakai S. Mortality of front-seat occupants attributable to unbelted rear-seat passengers in car crashes. Lancet 2002;359(9300):43-44.

(29) S. Nukenine. Factors that impact seat belt usage and injury severity of belted fron seat occupants. PhD [dissertation]. New Jersey: Faculty of New Jersey Insititute of Technology, Deaprtment of Civil and Environmental Engineering; January, 2011.

(30) Boontob N, Tanaboriboon Y, Kanitpong K, Suriyawongpaisal P. Effect of Seat Belt Use on Road Accidents in Thailand. Transportation Research Record: Journal of the Transportation Research Board 2007;2038(-1):84-92.

(31) Nelson DE, Bolen J, Kresnow M. Trends in safety belt use by demographics and by type of state safety belt law, 1987 through 1993. Am J Public Health 1998 Feb;88(2):245-249.

(32) Braver ER. Race, Hispanic origin, and socioeconomic status in relation to motor vehicle occupant death rates and risk factors among adults. Accident Analysis and Prevention 2003;35(3):295-309.

(33) Lund AK. Voluntary seat belt use among US drivers: Geographic, socioeconomic and demographic variation. Accid Anal Prev 1986;18(1):43-50.

(34) Lerner EB, Jehle DVK, Billittier IV AJ, Moscati RM, Connery CM, Stiller G. The influence of demographic factors on seatbelt use by adults injured in motor vehicle crashes. Accid Anal Prev 2001;33(5):659-662.

(35) Eluru N, Bhat CR. A joint econometric analysis of seat belt use and crash-related injury severity. Accid Anal Prev 2007;39(5):1037-1049.

(36) Ball CG, Kirkpatrick AW, Brenneman FD. Noncompliance with seat-belt use in patients involved in motor vehicle collisions. Can J Surg 2005;48(5):367-372.

(37) Schlundt DG, Briggs NC, Miller ST, Arthur CM, Goldzweig IA. BMI and seatbelt use. Obesity 2007;15(11):2541-2545.

(38) Strine TW, Beck LF, Bolen J, Okoro C, Dhingra S, Balluz L. Geographic and sociodemographic variation in self-reported seat belt use in the United States. Accid Anal Prev 2010;42(4):1066-1071.

(39) Acts South Africa. National Road Traffic Act, 1996 (Act No. 93 of 1996). Available at: http://www.acts.co.za/national-road-traffic-act-1996/ Accessed on: 22 March 2013.

(40) Matzopoulos R, Myers JE, Jobanputra R. Road traffic injury: prioritising interventions. S Afri Med J 2008;98(9):692.

(41) Statistics South Africa. City Statistics and Population Census: Census 2011: City of Cape Town. Available at: https://www.capetown.gov.za/en/stats/Pages/Census2011.aspx Accessed on: 22 March 2013.

(42) Western Cape Government. Medical Emergency Transport and Rescue (METRO). Available at: http://www.westerncape.gov.za/service/medical-emergency-transport-and-rescue-metro Accessed on: 22 March 2013.

(43) Moore EE, Cogbill TH, Jurkovich GJ, McAninch JW, Champion HR, Gennarelli TA, et al. Organ injury scaling III: Chest wall, abdominal vascular, ureter, bladder, and urethra. J Trauma 1992;33(3):337.

(44) Moore EE, Malangoni MA, Cogbill TH, Shackford SR, Champion HR, Jurkovich GJ, et al. Organ Injury Scaling IV: Thoracic Vascular, Lung, Cardiac, and Diaphrag. J Trauma 1994;36(3):299.

(45) Moore EE, Cogbill TH, Jurkovich GJ, Shackford SR, Malangoni MA, Champion HR. Organ injury scaling: spleen and liver (1994 revision). J Trauma 1995;38(3):323.

(46) Moore E, Cogbill T, Malangoni M, Jurkovich G, Champion H, Gennarelli T, et al. Organ injury scaling, II: Pancreas, duodenum, small bowel, colon, and rectum. J Trauma 1990;30(11):1427.

(47) Champion HR, Sacco WJ, Copes WS, Gann DS, Gennarelli TA, Flanagan ME. A revision of the Trauma Score. J Trauma 1989 May;29(5):623-629.

(48) Boyd CR, Tolson MA, Copes WS. Evaluating trauma care: the TRISS method. Trauma Score and the Injury Severity Score. J Trauma 1987 Apr;27(4):370-378.

(49) Teasdale G, Jennett B. Assessment of coma and impaired consciousness. A practical scale. Lancet 1974 Jul 13;2(7872):81-84.

(50) Copes WS, Champion HR, Sacco WJ, Lawnick MM, Keast SL, Bain LW. The injury severity score revisited. J Trauma 1988;28(1):69.

(51) Copes WS, Champion HR, Sacco WJ, Lawnick MM, Gann DS, Gennarelli T, et al. Progress in characterizing anatomic injury. J Trauma 1990;30(10):1200-1207.

(52) Baker SP, o'Neill B, Haddon Jr W, Long WB. The injury severity score: a method for describing patients with multiple injuries and evaluating emergency care. J Trauma 1974;14(3):187-196.

(53) Allen S, Zhu S, Sauter C, Layde P, Hargarten S. A Comprehensive Statewide Analysis of Seatbelt Non-use with Injury and Hospital Admissions: New Data, Old Problem. Acad Emerg Med 2006;13(4):427-434.

(54) Kononen DW, Flannagan CA, Wang SC. Identification and validation of a logistic regression model for predicting serious injuries associated with motor vehicle crashes. Accid Anal Prev 2011 Jan;43(1):112-122.

(55) Van Hoving DJ, Sinclair M, Wallis LA. Patterns of seatbelt use in different socioeconomic communities in the Cape Town Metropole, South Africa. S Afr Med J 2013 Aug 6;103(9):628-631.

(56) Olsen EO, Shults RA, Eaton DK. Texting while driving and other risky motor vehicle behaviors among US high school students. Pediatrics 2013;131(6):e1708-15.

(57) Chliaoutakis JE, Gnardellis C, Drakou I, Darviri C, Sboukis V. Modelling the factors related to the seatbelt use by the young drivers of Athens. Accid Anal Prev 2000 Nov;32(6):815-825.

(58) Chokotho L, Matzopoulos R, Myers J. Drivers' risk profile indicates the need for a graduated driving licence in South Africa. S Afr Med J 2012;102(9):749-751.

(59) Lardelli-Claret P, Espigares-Rodriguez E, Amezcua-Prieto C, Jimenez-Moleon JJ, Luna-del-Castillo Jde D, Bueno-Cavanillas A. Association of age, sex and seat belt use with the risk of early death in drivers of passenger cars involved in traffic crashes. Int J Epidemiol 2009 Aug;38(4):1128-1134.

(60) Cummings P, Rivara FP. Car occupant death according to the restraint use of other occupants. JAMA 2004;291(3):343-349.

(61) Mohammadi G. The pattern of fatalities by age, seat belt usage and time of day on road accidents. Int J Inj Contr Saf Promot 2009 Mar;16(1):27-33.

(62) Chaudhary NK, Preusser DF. Connecticut nighttime safety belt use. J Safety Res 2006;37(4):353-358.

(63) Vivoda JM, Eby DW, St Louis RM, Kostyniuk LP. A direct observation study of nighttime safety belt use in Indiana. J Safety Res 2007;38(4):423-429.

(64) Sasser SM1, Hunt RC, Faul M, Sugerman D, Pearson WS, Dulski T, et al. Guidelines for Field Triage of Injured Patients - Recommendations of the National Expert Panel on Field Triage, 2011. MMWR Recomm Rep 2012;61(RR-1):1-20.

(65) Staff T, Eken T, Wik L, Roislien J, Sovik S. Physiologic, demographic and mechanistic factors predicting New Injury Severity Score (NISS) in motor vehicle accident victims. Injury 2014 Jan;45(1):9-15.

(66) Abu-Zidan FM, Abbas AK, Hefny AF, Eid HO, Grivna M. Effects of seat belt usage on injury pattern and outcome of vehicle occupants after road traffic collisions: prospective study. World J Surg 2012 Feb;36(2):255-259.

(67) Aitken ME, Bowman SM, Card-Higginson P, Carson JE, Lin TM, Thompson JW, et al. Safety restraint use linked to hospital use and charges in Arkansas. J Ark Med Soc 2008 Jan;104(7):161-164.

(68) Kerwin AJ, Griffen MM, Tepas JJ,3rd, Schinco MA, Pieper P, Devin T, et al. The burden of noncompliance with seat belt use on a trauma center. J Trauma 2006 Mar;60(3):489-92; discussion 492-3.

(69) Williams RF, Fabian TC, Fischer PE, Zarzaur BL, Magnotti LJ, Croce MA. Impact of airbags on a Level I trauma center: injury patterns, infectious morbidity, and hospital costs. J Am Coll Surg 2008;206(5):962-8; discussion 968-9.