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# Injury severity in relation to seatbelt use in Cape Town, South Africa: A pilot study

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**Background.** Injuries and deaths from road traffic collisions present an enormous challenge to the South African (SA) healthcare system. The use of restraining devices is an important preventive measure.

**Objective.** To determine the relationship between seatbelt use and injury severity in vehicle occupants involved in road traffic collisions in Cape Town, SA.

**Methods.** A prospective cohort design was used. Occupants of vehicles involved in road traffic collisions attended to by EMS METRO Rescue were included during the 3-month data collection period. Triage categories of prehospital patients were compared between restrained and unrestrained groups. Patients transferred to hospital were followed up and injury severity scores were calculated. Disposition from the emergency centre and follow-up after 1 week were also documented and compared.

**Results.** A total of 107 patients were included in the prehospital phase. The prevalence of seatbelt use was 25.2%. Unrestrained vehicle occupants were five times more likely to have a high triage score (odds ratio (OR) 5.4; 95% confidence interval (CI) 1.5 - 19.5). Fifty patients were transferred to study hospitals. Although seatbelt non-users were more likely to be admitted to hospital ($p$=0.002), they did not sustain more serious injuries (OR 0.44; 95% CI 0.02 - 8.8).

**Conclusion.** The prevalence of seatbelt use in vehicle occupants involved in road traffic collisions was very low. The association between seatbelt non-use and injury severity calls for stricter enforcement of current seatbelt laws, together with the development and implementation of road safety interventions specifically focused on high-risk groups.

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The contribution of road traffic injuries to the burden of injury is an emerging priority worldwide. The latest global road traffic mortality rate is 18/100 000 persons, and about 14 000 deaths a year result from accidents on South African (SA) roads.[1]

Many road traffic injuries are preventable. Although it is unrealistic to expect that all collisions can be prevented, it is certainly possible to implement measures to reduce the impact of a collision and hence decrease serious injuries or death. Risk factors that contribute to serious road traffic injuries can be categorised into five groups: (*i*) driver attributes (e.g. young age, substance abuse, seatbelt use); (*ii*) vehicle characteristics (e.g. type and weight of vehicle); (*iii*) road design (e.g. presence of shoulders, speed limits); (*iv*) environmental factors (weather, time of day, etc.); and (*v*) crash characteristics (e.g. roll-over, ejection of occupants).[2]

SA has numerous road safety strategies in place, but it is unclear how effective they have been in reducing this burden of disease. The fact that nationally fatal injury levels remain largely unchanged year after year suggests that current strategies are falling short of addressing the problem effectively.[2]

One of the main problems is the data on traffic injuries. Data collection is commonly recognised to be undermined by problems of under-reporting, poor quality of reporting and disorganised record storage. It further concentrates on recording only the broadest details around the physical circumstances of the incident, e.g. the location, date, time, type of vehicle, etc. In the process, very little effort is spent on detailing the nature of the injuries sustained by the victims and the circumstances influencing those injuries, e.g. their position in the vehicle, evidence of seatbelt use, etc.

SA has one of the lowest rates of seatbelt use (±60%) in the world, despite international research confirming that use of seatbelts is the most important factor affecting the risk of death in the event of a serious collision.[1] Unfortunately this information is not routinely collected in standard collision reporting forms in SA, and the relationship between these rates and injury severity has not been quantified.

Determining patterns in road behaviour has the potential to allow an evidence-based approach to preventing road traffic collisions in the future; by understanding the specific dimensions of and factors affecting injury severity, we will be better placed to develop and implement strategies that show promise in terms of reducing injury severity. Furthermore, the addition of hospital data to mortuary and police reports would increase the knowledge base regarding the effect of seatbelt non-use on the occupants of vehicles involved in road traffic collisions. The aim of this pilot study was to determine the relationship between seatbelt use and injury severity in patients involved in road traffic collisions in Cape Town, Western Cape Province, SA.

## Methods

### Study design

A prospective cohort design was used. The study had two phases, a prehospital phase in which persons involved in road traffic collisions were identified and evaluated, and a second in-hospital phase assessing all patients transported to study hospitals.

### Study setting

The study was done in the City of Cape Town, a metropolitan municipality of SA covering an area of 2 461 km$^2$, with an estimated population of 3.7 million.[3] The Western Cape Department of Health: Emergency Medical Services (EMS) provides medical response and prehospital services to the public. This 24-hour service is the first medical contact point for ill or injured patients. After the necessary medical stabilisation, patients are transferred to the nearest hospital deemed appropriate to handle their condition. EMS also provides various technical rescue services, including aquatic rescue, aviation rescue and extricating the occupants of wrecked vehicles. Although the standard operating procedure stipulates that rescue technicians can be dispatched to any road traffic collision, they are typically called out to severe collisions (e.g. multi-vehicle involvement, roll-overs, entrapped vehicle occupants). The rescue technicians' primary responsibility is patient extrication, and they are only involved in patient care when other emergency services are unavailable.

This study was approved by the Stellenbosch University Health Research Ethics Committee (N11/03/080).

### Study population

Occupants of vehicles involved in road traffic collisions in the Cape Town metropole attended to by EMS METRO Rescue during the 3-month data collection period (1 June 2012 - 31 August 2013) were eligible for inclusion in the prehospital phase. Occupants of buses, taxis, non-motorised vehicles, heavy goods vehicles, emergency vehicles and two-wheel motorised vehicles were excluded. Patients were included in the in-hospital phase of the study if they were transferred to one of six hospitals (Groote Schuur Hospital, Tygerberg Hospital, G F Jooste Hospital, New Somerset Hospital, Victoria Hospital and Red Cross War Memorial Children's Hospital).

### Data collection and management

The METRO Rescue team is based in Pinelands, Cape Town, and serves the entire Cape Town metropole. This team assisted with prehospital data collection, completing a standardised data collection sheet for each vehicle occupant involved in a road traffic collision. The South African Triage Scale (SATS) was used to prioritise patients (red = emergency; orange = very urgent; yellow = urgent; green = non-urgent; blue = dead).[4] The data were collected in such a way as to protect patient confidentiality, and no personal or identifying information was collected for patients who were uninjured or discharged directly from the scene. However, identifying information for patients transferred to hospital was captured on the prehospital 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 data sheets on a weekly basis from the METRO Rescue base.

The patient report form (PRF) or incident number, together with the patient's name, was used to link the prehospital and in-hospital data. Patients were identified in the various trauma admissions books, using the date, time and type of accident or injury. Correlating folder numbers were obtained and data were retrieved from folders. The hospital data were linked to a specific study code. Only the hospital folder number of the patient, and no further personal or identifying information, was collected. Patients admitted to study hospitals were followed up 1 week after the admission date. Data were recorded on a standardised data collection sheet. The Injury Severity Score (ISS) was used to determine injury severity. The hospital data collector was blinded to whether patients had been using seatbelts or not.

The collected data were entered onto an electronic spreadsheet (Microsoft Excel). The spreadsheet contained only the study code. A separate data file containing the identifying names, folder numbers and PRF or incident numbers was kept securely 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 spreadsheets were password protected.

### Statistical analysis

Data were analysed by the Centre for Statistical Consultation at Stellenbosch University using Statistica version 10 (2012). Variables were described using summary statistics. The prevalence of seatbelt use was calculated and compared between different variables. The relationship between two nominal variables was investigated using Pearson's $\chi^2$ test. The relationships between continuous response variables and nominal input variables were analysed using appropriate analysis of variance. Non-parametrics were used when ordinal response variables were compared with nominal input variables. For completely randomised designs, the Mann-Whitney *U* test was used. The significance level was set as $p<0.05$.

## Results

### Prehospital phase

METRO Rescue responded to 367 road traffic collisions during the 3-month study period. Data were collected on 205 patients from 55 collisions; 98 patients were excluded (Fig. 1). A total of 107 patients were therefore included in the prehospital phase (55 drivers, 28 front seat passengers and 24 rear seat passengers). The mean age of the vehicle occupants was 34.6 years (drivers 36.6, front seat passengers 33.8, rear seat passengers 30.6). Three occupants were younger than 13 years of age.

The prevalence of seatbelt use was 25.2% overall ($n$=27) (drivers 34.5% ($n$=19), front seat passengers 21.4% ($n$=6), rear seat passengers 8.3% ($n$=2)). The mean ages of patients who had and had not been using a seatbelt were 36.9 years ($n$=74) and 33.4 years ($n$=23), respectively ($p$=0.23) (incomplete data $n$=10). Gender did not appear to influence seatbelt use significantly ($p$=0.49; males $n$=14, 22.9%; females $n$=13, 28.9%).

With regard to time of seatbelt use, the rate of use was highest during the middle of the day (12h00 - 16h00), with very low use during the early morning and late at night (Fig. 2). This association was not statistically significant ($p$=0.13). Eighteen vehicle occupants had incomplete data.

A statistically significant association between not wearing a seatbelt when involved in a road traffic collision and triage category was demonstrated ($p$=0.02) (Table 1). Dead or seriously injured

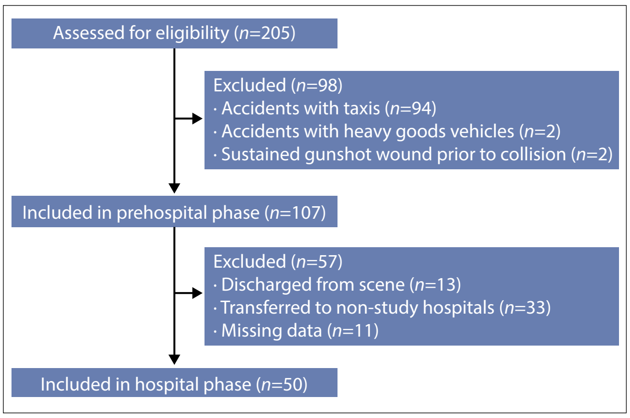


*Fig. 1. Flow diagram of the study population.*

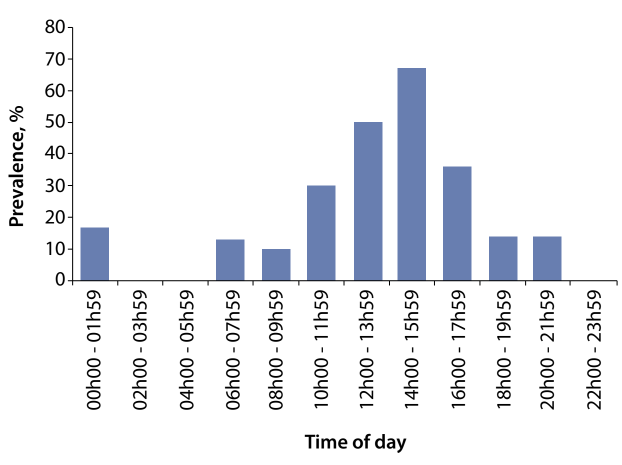


*Fig. 2. Influence of time of day on the prevalence of seatbelt use.*

**Table 1. Influence of seatbelt use on prehospital injury acuity**

| Triage category | No seatbelt *n* (%) | Wearing seatbelt *n* (%) | Total* |
|---|---|---|---|
| Green (non-urgent) | 15 (57.7) | 11 (42.3) | 26 |
| Yellow (urgent) | 31 (70.5) | 13 (29.5) | 44 |
| Orange (very urgent) | 10 (76.9) | 3 (23.1) | 13 |
| Red (emergency) | 10 (100.0) | 0 (0.0) | 10 |
| Blue (dead) | 11 (100.0) | 0 (0.0) | 11 |

*Incomplete data *n*=3.

**Table 2. Association of seatbelt use and possible confounders**

| | No seatbelt *n* (%) | Wearing seatbelt *n* (%) | *p*-value |
|---|---|---|---|
| Position in car (*n*=107) | | | 0.12 |
| Driver | 36 (65.5) | 19 (34.5) | |
| Front seat passenger | 22 (78.6) | 6 (21.4) | |
| Rear seat behind driver | 8 (100) | 0 (0) | |
| Rear seat middle | 5 (100) | 0 (0) | |
| Rear seat behind front passenger | 9 (81.8) | 2 (18.2) | |
| Roll-over (*n*=98) | | | 0.38 |
| Yes | 26 (83.9) | 5 (16.1) | |
| No | 51 (76.1) | 16 (23.9) | |
| Site of impact (*n*=105) | | | 0.54 |
| Driver side | 23 (79.3) | 6 (20.7) | |
| Passenger side | 14 (70.0) | 6 (30.0) | |
| Front | 28 (70.0) | 12 (30.0) | |
| Rear | 7 (70.0) | 3 (30.0) | |
| All four sides | 6 (100) | 0 (0) | |
| Entrapped (*n*=107) | | | 0.43 |
| Yes | 14 (82.4) | 3 (17.6) | |
| No | 66 (73.3) | 24 (26.7) | |

patients (triaged blue, red and orange) were five times less likely to have worn a seatbelt than those with less severe injuries (odds ratio (OR) 5.4; 95% confidence interval (CI) 1.49 - 19.47). None of the 11 patients who died had been restrained ($p$=0.03).

Eighty-three patients were transferred to hospitals (seatbelt $n$=19, 22.9%), while 13 were discharged directly from the scene (seatbelt $n$=8, 61.5%) (11 had incomplete data). Vehicle occupants who had not been wearing seatbelts were significantly more likely to be transferred to hospital ($p$=0.002).

There were no significant associations between seatbelt use and position in the vehicle, roll-over of the vehicle, site of impact or entrapment of occupants (Table 2).

## In-hospital phase

After excluding 33 patients who were transported to non-study hospitals, 50 patients were followed through to the various study hospitals (Fig. 1). Only six patients (12.0%) had been restrained.

The median ISS for all hospitalised patients was 6.0 (interquartile range (IQR) 2.3 - 11.0), for restrained patients 7.5 (IQR 2.25 - 9.0), and for unrestrained patients 5.5 (IQR 2.75 - 11) ($p$=0.67). The highest ISS in the seatbelt group was 11 v. a maximum of 75 in the no-seatbelt group (Table 3). Patients were then divided into those with serious injuries (ISS ≥15) and less serious injuries (ISS <15). Although none of the seven patients who sustained serious injuries had been using a seatbelt, there was no statistically significant difference between use of seatbelts and being seriously injured (OR 0.44; 95% CI 0.02 - 8.8).

Patients sustained a total of 134 injuries, of which only 13 (9.7%) occurred in the seatbelt group. The majority of injuries were to the extremities ($n$=38, 28.4%), the neck ($n$=27, 20.1%) and the chest ($n$=24, 17.9%) (Fig. 3).

**Table 3. ISSs for hospitalised patients**

| ISS | Wearing seatbelt | No seatbelt | All |
|---|---|---|---|
| 1 | 2 | 4 | 6 |
| 2 | 0 | 7 | 7 |
| 3 | 0 | 4 | 4 |
| 4 | 0 | 4 | 4 |
| 5 | 0 | 3 | 3 |
| 6 | 1 | 3 | 4 |
| 9 | 1 | 4 | 5 |
| 10 | 1 | 2 | 3 |
| 11 | 1 | 3 | 4 |
| 13 | 0 | 1 | 1 |
| 14 | 0 | 2 | 2 |
| 17 | 0 | 1 | 1 |
| 22 | 0 | 1 | 1 |
| 24 | 0 | 1 | 1 |
| 25 | 0 | 1 | 1 |
| 27 | 0 | 1 | 1 |
| 50 | 0 | 1 | 1 |
| 75 | 0 | 1 | 1 |
| Total | 6 | 44 | 50 |
| Mean (SD) | 6.3 (4.46) | 10.2 (13.65) | 9.74 (12.93) |

ISS = Injury Severity Score; SD = standard deviation.

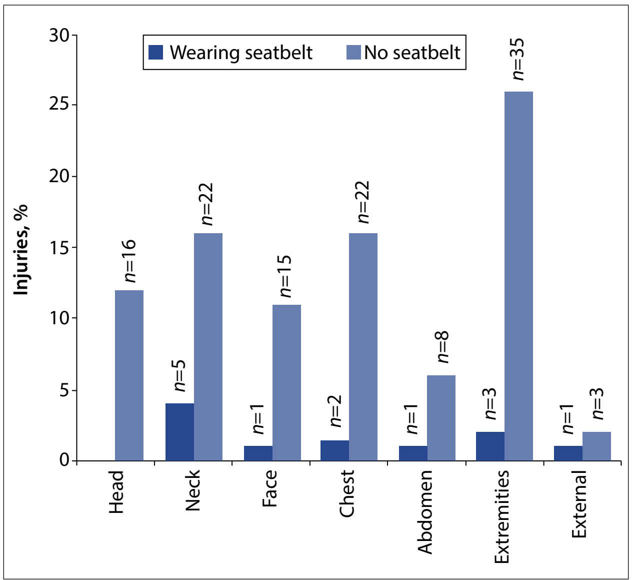


*Fig. 3. Injured body regions stratified according to seatbelt use. (External: lacerations, contusions, abrasions and burns, independent of their location on the body surface.)*

Disposition from the emergency centre or trauma unit did not differ according to seatbelt use ($p$=0.92). Twenty-six patients (52%; wearing seatbelt $n$=3, 11.5%) were directly discharged, whereas 24 were admitted, only three (12.5%) of whom had worn seatbelts. At the 1-week follow-up, only eight patients (16.0%) remained in hospital (not wearing seatbelt $n$=7) and one patient had died. The association between not wearing a seatbelt and increased hospital stay was not significant ($p$=0.44).

Twelve patients died during the study period (11 in the prehospital phase and one in hospital). None of them had been wearing a seatbelt.

## Discussion

The low prevalence of seatbelt use (25%) is a concern, and this figure is considerably lower than the 59% published by the World Health Organization.[1] The prevalence in patients involved in road traffic collisions in KwaZulu-Natal was only 17%, indicating that the actual seatbelt wearing rate is vastly over-estimated.[5]

People have many excuses for not wearing seatbelts (e.g. 'it's uncomfortable', 'my car has airbags', 'I'm a good driver'), but there may in fact be a relationship between seatbelt compliance and safe driving. International research has shown that people involved in road traffic accidents comply with seatbelt regulations less often than the rest of the general public.[6] Vehicle occupants not wearing seatbelts are generally young, male, and have poor driving habits (driving under the influence of alcohol, speeding, previous road traffic collisions and driving offences).[6–9] We also found that seatbelt use decreased dramatically during night-time driving (Fig. 2), but this trend is also not unique to Cape Town.[6,9,10] Road traffic collisions at night are often not a result of poor vision in the dark, but rather a consequence of driver-associated factors (e.g. increased rates of intoxication).[9] The abovementioned studies[6–9] 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 intentionally engaging in multiple risky behaviours.[6–9] Whether SA seatbelt behaviour is comparable to these international examples is as yet unclear. What we do know is that rates of seatbelt use are significantly lower than the international standard for all vehicle occupant classes, which indicates that not wearing seatbelts may be less intentional than simply habitual. In either case, a great deal can and should be done to influence seatbelt wearing rates. Injury prevention programmes should be designed to selectively target these high-risk drivers in order to improve seatbelt compliance.

A strong association between seatbelt use and prehospital triage assessment was demonstrated (OR 5.4). This is similar to a prehospital study in Qatar, where unbelted vehicle occupants were nearly twice as likely as those who used seatbelts to suffer severe injury or death.[11] It has also been suggested that several mechanical factors, including seatbelt use, be included in prehospital triage to reduce under-triage and help anticipate the need for high-level care.[12]

Multiple studies have highlighted the association between seatbelt non-compliance and injury severity, mortality, and disposition from the emergency centre or trauma unit.[6,8,13,14] In a prospective study ($N$=766) in the United Arab Emirates, belted occupants had a lower mean ISS (6.1 v. 9.4; $p$=0.001), a shorter hospital stay (5.3 v. 9.6 days; $p$=0.005) and a lower mortality rate (1.5% v. 2.4%; $p$=0.075).[8] A study in the USA ($N$=23 920) evaluated the Wisconsin Crash Outcome Data Evaluation System (CODES) database and found that admission rates were twice as high and mortality rates three times higher in the unbelted group.[14] The percentage of vehicle occupants without seatbelts also increased with increased injury severity.[14] Cummins *et al.*[13] evaluated 184 992 patients and demonstrated a reduction in both mortality (adjusted OR 0.49; 99% CI 0.45 - 0.52) and serious injuries (adjusted OR 0.509; 99% CI 0.49 - 0.53). The fact that these associations were not very apparent during the hospital phase of our study can be attributed to a number of limitations of this pilot study (see below): further, the small sample size ($n$=50) and the low seatbelt compliance rate ($n$=6, 12.0%) in the hospital cohort could have masked a true effect, and the majority of the patients ($n$=43, 86.0%) were also not seriously injured (ISS <15), seeming to eliminate the safety effect of seatbelts. On the other hand, the breakdown of injured body regions (Fig. 2) and the fact that all the patients who died ($n$=12) were unbelted emphasise the protective value of seatbelts.

### Study limitations

This was a pilot study, and data collection was only done for a 3-month period and not until a specified sample size was reached. This resulted in a small sample size with limited statistical inference. Data were only collected on patients involved in collisions that were considered to be serious, to which METRO Rescue responded and where patients were transferred to certain study hospitals. We acknowledge that this study under-represents road traffic collisions in Cape Town, but still see the data as useful. Second, the study does not specify whether seatbelts were in working condition, whether they were fitted correctly, whether they were used appropriately, or indeed whether they were fitted to all the vehicles (some vehicles on SA roads are very old). Third, ethanol inebriation is an important factor in road traffic collisions, but was not measured. The international literature is contradictory, with studies indicating both a negative and a positive correlation between blood alcohol values and injury severity.[7,15] It is therefore unlikely that ethanol inebriation could have had a massive influence on the results. Fourth, the in-hospital follow-up was mainly completed from hospital records, which had various missing variables. However, the likelihood of loss to follow-up was similar in the belted and unbelted groups, minimising any effect on the estimate of association. Finally, miscalculation of the ISS could have resulted in either under- or overestimation of the severity of injuries. This potential error was overcome through adequate training of the data collector, periodic monitoring and cross-checking of the results by the principal investigator.

## Conclusion

This study demonstrated a reduction in injury severity, hospital admission rate, duration of hospital stay and mortality rate when seatbelts were used by occupants of vehicles involved in road traffic collisions. Consistent with previous 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.

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