# Seatbelt Use in Qatar in Association with Severe Injuries and Death in the Prehospital Setting

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**Abbreviations:**
AVPU = alert, verbal, pain, unresponsive
EMS = emergency medical services
GCS = Glasgow Coma Scale
HMC = Hamad Medical Corporation
PCR = prehospital care record
RTC = road traffic crash

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## Abstract

**Introduction:** Road traffic crashes (RTCs) are common in Qatar, and are now considered the third leading cause of mortality. In this study, the safety devices used by the Qatari public at the time of RTCs were assessed and the association between seatbelt use by vehicle occupants involved in RTCs and severe injury/death in the prehospital setting was determined.

**Methods:** This study was a retrospective case-control investigation. A Hamad Medical Corporation Emergency Medical Services (EMS) database of RTCs occurring from January 2006 to April 2007 was utilized for this study, providing a total of 5,267 patient records (83.5 % male, 16.5% female, median age = 28 years). Patient demographics, crash characteristics, prehospital assessments, and interventions were identified, and use of safety devices was determined. Univariate analysis including chi-square, Student's *t*-test, and analysis of variance (ANOVA) was performed as appropriate. "Case" patients are defined as those who had specific, critical prehospital assessments, or who received advanced cardio-respiratory life support measures in the field. Logistic regression modeling was used to predict the probability of a case being unbelted, controlling for confounders.

**Results:** Seatbelt use in Qatar was low: 33.9% of males and 32.6% of females wore seatbelts at the time of the RTC. Victims involved in a vehicle rollover crash were less likely to be belted than were those involved in a non-rollover incident (26.2% belted vs. 37.8%; OR = 0.59; 95%CI = 0.50–0.68). Case patients—those with defined critical assessment findings or resuscitation in the field—and control patients were similar in age (30 years vs. 28 years median). Case patients were disproportionately male (89.1% vs. 83.2%; OR = 1.65; 95%CI = 1.01–2.83) and were more likely to be victims of a vehicle rollover crash (44.7% vs. 23.8%; OR = 2.57; 95%CI = 1.84–3.59). Seatbelt use was significantly lower among cases than controls: 19.7% of cases were reported to have worn seatbelts compared to 34.2% of controls (OR = 0.47; 95%CI = 0.31–0.69). This relationship also persisted (OR = 0.51; 95%CI = 0.33–0.76) after controlling for confounders.

**Conclusions:** Seatbelt use in Qatar is low. Seatbelts are protective: in the prehospital setting unbelted vehicle occupants involved in RTCs were nearly twice as likely to suffer severe injury or death compared to belted patients. Prehospital morbidity and mortality appears to be reduced significantly by the consistent use of seatbelts by the motoring population in Qatar.

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## Introduction

Qatar is a rapidly developing, oil- and petroleum-rich nation in the Middle East where road traffic crashes (RTCs) are becoming increasingly common. The nation is in the midst of an epidemic of road traffic deaths, which now count as the third leading cause of death, particularly among the young.[1] Based on investigations of seatbelt use in Qatar and in other Gulf states, it is probable that the use of seatbelts and other safety devices by the Qatari pub-

lic is low, and that this trend contributes to the road-traffic morbidity and mortality rate.[2] During the past 30 years, a wealth of global literature has identified the protective effects of seatbelt use, generally correlating seatbelt use to subsequent hospital admission, length of hospital stay, cost of care, and clinical outcome.[3–9] However, there has been scant investigation in the rapidly developing Middle East, and no published research has examined the relationship between seatbelt use and subsequent death and morbidity in the Middle Eastern prehospital setting. Such data are valuable for emergency medical services (EMS) and trauma center planning, and for public health purposes.

In this study, a retrospective review of EMS data from the Hamad Medical Corporation was performed to determine the relationship between seatbelt use and severe injury or death among RTC victims. Hamad Medical Corporation is the sole public EMS provider in Qatar. With limited exceptions, every RTC victim with injuries is represented in the database. Hamad Medical Corporation is a rapidly growing, advanced life support agency with a 2007 annual call volume of 43,000 emergency calls. The EMS database contains information from any call for which an ambulance was dispatched, and contains information abstracted from the prehospital care record (PCR), as well as information collected by emergency telephone operators. It was hypothesized that seatbelt use by vehicle occupants involved in RTCs would protect against severe injuries and death as observed in the prehospital setting.

## Methods

This study was a retrospective, case-control investigation using data from the EMS department's database, during a 16-month period: 01 January 2006–30 April 2007. This period was selected as it preceded the national road-traffic and emergency medicine awareness campaigns that could influence seatbelt use patterns. This study assessed the relationship between seatbelt use and severe morbidity and death, as recorded by EMS personnel. The retrospective review conducted in this study examined the call characteristics and the care rendered to RTC victims. In addition, victims' use of seatbelts was correlated to their likelihood of sustaining severe injuries or rapid death when involved in a crash. "Cases" were defined as those RTC victims who had specific, critical prehospital assessments, or who received advanced cardio-respiratory life support measures in the field. Patients may have subsequently died or experienced severe morbidity after arriving at a hospital, but not necessarily would have been considered a case in the prehospital setting. The study protocol was reviewed and granted exempted status by both the Hamad Medical Corporation and University of Pittsburgh Institutional Review Boards.

Records were requested for patients who were vehicle occupants involved in a road traffic crash, and who were seen or transported by EMS during the 16 month period. An anonymous dataset of 5,505 patients from the EMS database was provided. Patients <8 years of age (n = 165) were excluded, since they were too young to wear seatbelts, and were more properly restrained in car seats. Patients transported by the EMS "Green Bus" (mass-casualty van) (n = 73) were excluded, as these patients generally were walking wounded from crashes, usually involving buses that generally do not have seatbelts. A total of 5,267 records were reviewed, and these patients were entered into the study (83.5 % male, 16.5% female, median age = 28 years).

Patient age, nationality, gender, and position (driver, front seat passenger, rear seat passenger) were collated. The following information was collected: (1) type of impact (head on, rear end, side, ejection); (2) vehicle deformity (minor, significant); (3) location of the crash (urban or rural); (4) type of crash (rollover, collision with vehicle, collision with fixed object, collision with animal, collision with pedestrian); (5) the location of the crash (roundabout, intersection, signal, roadway); (6) the type of road (main, midblock, one-way road, two-way road, rural and urban); and (7) destination hospital.

Seatbelt use was categorized into the following groups: (1) yes = seatbelt use was definitively recorded by paramedics; (2) no = seatbelt was not worn, or was not recorded by crew's observation. A distinction between lack of seatbelt use and unknown seatbelt use could not be ascertained due to the format of the recording box on the PCR. Airbag deployment was similarly recorded.

Selected patient assessment variables were examined including: (1) cardiac arrest (yes or no); (2) level of consciousness using the AVPU (alert, verbal, pain, unresponsive) scale; (3) airway status (open, compromised); (4) breathing (rapid, normal, slow, apneic); and (5) circulation (pulse rapid, normal, absent). Information was collected regarding the following selected patient treatment variables: (1) airway management (endotracheal intubation, oral airway, combitube, cricothyroidotomy, other); (2) defibrillation performed (yes or no); and (3) oxygen administered (cannula; non-rebreather mask; bag-valve-mask).

In order to determine the effects of seatbelt use on injury severity and death, using a number of variables related to assessment and care of patients were used to define a case patient. Each variable was selected as an independent indicator of significant morbidity or death in the prehospital setting. A patient was considered to have been severely injured or dead (and thus a case), if, prior to or during the course of EMS care, the patient: (1) developed cardiac arrest; (2) was unresponsive, or was responsive to voice or pain (AVPU = V, P or U); (3) was apneic; or (4) had absent circulation (generally an unobtainable blood pressure). Administration of treatments also identified a case. Patients were included if, during the course of the provision of EMS care, they required: (1) intubation, Combitube insertion, cricothyroidotomy, or placement of an orophayngeal airway; or (2) defibrillation. A total of 177 cases were identified. The control group (n = 5,090) included all remaining patients in the initial cohort who did not meet the inclusion criteria; these were patients treated and/or transported by EMS with less-than-severe injury(ies), but not necessarily patients without injury. Cases, presented by inclusion criteria, are described in Table 1.

Data management and analysis was performed using STATA, version 9.0 for Macintosh [StataCorp, College Station, TX]. Simple descriptive statistics were obtained

| Category | Variable | (n) |
|---|---|---|
| LOC | Verbal | 52 |
| | Pain | 42 |
| | Unresponsiveness | 75 |
| Airway | Oral | 24 |
| | Combitube | 1 |
| | ETT | 62 |
| | Cricothyroid/ Other | 2 |
| Cardiac | Cardiac Arrest | 19 |
| | Defibrillation | 7 |



**Table 1**—Inclusion variables for patients identified as cases. Total cases = (n = 177) Number of inclusion variables exceed number of study cases, as cases frequently met several criteria.
(ETT = endotracheal tube)

and statistical significance was defined as $p$ <0.05 (two-tailed). Odds ratios and 95% confidence limits were determined as was the percentage of belted and unbelted occupants. Univariate analysis included chi-square, Student's $t$-test, and ANOVA (as appropriate). Logistic regression modeling was used to calculate the odds of sustaining severe injury (being a case) if unbelted, controlling for age, gender, airbag use, location of victim in vehicle, type of collision (rollover or non-rollover), mechanism of crash (frontal or rear), and urban or rural crash. These covariates were determined by available data and likely confounders determined from prior literature. Those with significant or near-significant association with being a "case" using univariate analysis were added to the logistic regression model. By backward elimination the model was refined by manipulating included variables to determine the unconfounded effect of belt use.

## Results

The characteristics of the occupants, vehicles, and crashes in the belted and unbelted groups are listed in Table 2. The median age in both groups was similar (30 years unbelted, 27 years belted). The percentage of males wearing seatbelts did not differ significantly from females: in both groups around one-third of vehicle occupants were recorded as having worn a belt at the time of the RTC. Victims involved in a rollover were less likely to be belted than were those involved in non-rollover incidents (26.2% belted vs. 37.8% belted in the non-rollover group; OR = 0.59; 95%CI = 0.50–0.68). The RTC victims in rural areas were less likely to wear belts than were drivers in urban areas (29.5% vs. 35.5% respectively, OR = 0.76; 95%CI = 0.66–0.86). As a group, drivers were more likely to wear belts than passengers (40.0% vs. 27.3% respectively; OR = 1.40; 95%CI = 1.22–1.59). When the location of the passenger was assessed, passengers in the rear of the vehicle were less likely to have worn a belt

| | No Belt n (%) | Belt n (%) | OR (95%CI) |
|---|---|---|---|
| Age, Years Median | 30 | 27 | |
| Male | 2885 (66.1) | 1485 (33.9) | 1.06 (0.90–1.24) |
| Female | 584 (67.4) | 282 (32.6) | |
| Rollover | 861 (73.8) | 306 (26.2) | 0.59 (0.50–0.68) |
| No Rollover | 2,235 (62.2) | 1,356 (37.8) | |
| Driver | 1,674 (60.0) | 1,114 (40.0) | 1.40 (1.22- 1.59) |
| Rear Passenger | 450 (76.1) | 142 (23.9) | 0.32 (0.25–0.42) |
| Front Passenger* | 256 (50.3) | 259 (49.7) | |
| Rural | 1,091 (70.5) | 456 (29.5) | 0.76 (0.66–0.86) |



**Table 2**—Baseline Statistics Total Cohort: Patients Belted vs. Unbelted. Percentages reflect row totals. Passenger location unknown for (n= 501) passengers (CI = confidence interval; OR = odds ratio)

than front passengers (23.9% vs. 49.7% respectively; OR = 0.32; 95%CI = 0.25–0.42) or drivers.

Non-Qatari citizens represent 71.5% of RTC vehicle occupants in Qatar. There was a wide variation in the ratio of belted to unbelted victims sorted by nationality. Belt use ranged from 11% to 92% among nationalities represented by more than 5 patients (Table 3).

Case and control patients were similar in age (30 years vs. 28 years median). Cases were disproportionately male (89.1% vs. 83.2%) compared to controls (OR = 1.65; 95%CI = 1.01–2.83). Cases were less frequently occupants of vehicles involved in a front-impact collision compared to controls (59.7% vs. 75.9% respectively; OR = 0.47; 95%CI = 0.32–0.68) and were more likely to be victims of a rollover incident (44.7% vs. 23.8%; OR = 2.57; CI 1.84–3.59). Case patients were disproportionately injured in rural crashes (37.3% vs. 29.1%; OR = 1.45; 95%CI 1.04–1.99) (Table 4). Crashes involving case patients were more likely to have required multiple ambulances; 95.4% of case patient crashes required more than one ambulance vs. 78.1% of control crashes (OR = 5.9; 95%CI 2.9–13.9). These results are summarized in Table 4. Cases were more likely than control to have been brought to Hamad General Hospital, the largest hospital in the country, 72.6% control vs. 87.3% case ($p$ = 0.03).

Seatbelt use was significantly lower among cases than controls: 19.7% of patients meeting the case definition were reported to have worn seatbelts compared to 34.2% of con-

| Nationality | No Belt (n) | Belt (n) | Total (n) | % Unbelted |
|---|---|---|---|---|
| Serbia | 1 | 12 | 13 | 7.7 |
| Korea | 2 | 4 | 6 | 33.3 |
| Australia | 3 | 5 | 8 | 37.5 |
| Eritia | 4 | 6 | 10 | 40.0 |
| Tunesia | 13 | 11 | 24 | 54.2 |
| Thailand | 5 | 4 | 9 | 55.6 |
| Algeria | 4 | 3 | 7 | 57.1 |
| Palestine | 92 | 68 | 160 | 57.5 |
| Pakistan | 135 | 97 | 232 | 58.2 |
| Egypt | 313 | 218 | 531 | 59.0 |
| Ethiopia | 11 | 7 | 18 | 61.0 |
| Sudan | 103 | 65 | 168 | 61.3 |
| India | 370 | 229 | 599 | 61.8 |
| Jordan | 94 | 58 | 152 | 61.8 |
| Yemen | 53 | 30 | 83 | 63.9 |
| USA | 16 | 9 | 25 | 64.0 |
| Iran | 63 | 35 | 98 | 64.2 |
| UK | 9 | 5 | 14 | 64.3 |
| Sri Lanka | 144 | 79 | 223 | 64.6 |
| Lebanon | 45 | 21 | 66 | 68.2 |
| Syria | 128 | 52 | 180 | 71.1 |
| Morocco | 5 | 2 | 7 | 71.4 |
| Qatar | 1,054 | 383 | 1,437 | 73.4 |
| Nepal | 278 | 91 | 369 | 75.3 |
| Turkey | 7 | 2 | 9 | 77.8 |
| Saudi Arabia | 33 | 8 | 41 | 80.5 |
| Oman | 52 | 12 | 64 | 81.3 |
| Philippines | 37 | 6 | 43 | 86.1 |
| Indonesia | 7 | 1 | 8 | 87.5 |
| Somalia | 15 | 2 | 17 | 88.2 |
| Kuwait | 8 | 1 | 9 | 88.9 |



**Table 3**—Rank order percent unbelted by nationality. Includes all nationalities with >5 persons represented as patients

trol victims (OR = 0.47;95%CI 0.31–0.69). This relationship persisted (OR = 0.51; 95%CI = 0.33–0.76) even after controlling for gender, presence of rollover, urban or rural location of crash, and destination hospital the variables most strongly associated with the outcome of interest in the logistic model.

## Discussion

This study of seatbelt use in Qatar indicates that a minority of vehicle occupants were belted at the time of a RTC. The use

| | Case n (%) | Control n (%) | OR (95%CI) |
|---|---|---|---|
| Age, Years Median | 30 | 28 | |
| Male | 156 (89.1) | 4,214 (83.2) | 1.65 (1.01–2.83) |
| Female | 19 (10.1) | 847 (16.8) | |
| Rollover | 71 (44.7) | 1,096 (23.8) | 2.57 (1.84–3.59) |
| No Rollover | 88 (55.3) | 3,509 (76.2) | |
| Driver | 104 (71.2) | 2,684 (63.1) | 1.44 (0.99–2.13) |
| Front Passenger | 9 (37.5) | 506 (46.8) | 1.46 (0.59–3.82) |
| Rear Passenger | 15 (62.5) | 577 (53.2) | |
| Rural | 66 (37.2) | 1,481 (29.1) | 1.44 (1.04–1.99) |
| Non-rural | 111 (62.8) | 3,609 (70.9) | |



**Table 4**—Baseline statistics. Victims with prehospital severe injury or death (cases) vs. control group. Percentages reflect variable contribution to total number of cases or controls. Passenger location unknown for 501 passengers

of a seatbelt was associated with a lower likelihood of severe injury or death in the prehospital setting immediately following a road traffic crash. The protective effect of seatbelts in this setting was 49%, even after controlling for confounders.

This study indicates that safety belt use is universally poor, with 33% of RTC victims wearing a belt at the time of their crash. This contrasts with an earlier study by Bener *et al* investigating seatbelt use before and after a Qatari safety belt law was passed. This study described a higher rate of belt use with compliance reported to have increased from 8% in 2001 to 69% in 2004.[2] Additionally, this research contradicts a 59% post-campaign seatbelt compliance rate described in a recent study of drivers in neighboring Abu Dhabi.[10] It is unclear why this discrepancy exists, but it is possible that seatbelt campaigns may be followed by a "honeymoon" period of high belt use, and that by 2006, seatbelt use had fallen from its peak.

The RTC patients in this study were young, with a median age of 27 years. It is assumed that youth and risky driving may be responsible for a many of RTCs in Qatar. Rollover mechanisms, which often are associated with high speeds, revealed a particularly low seatbelt use by vehicle occupants, and greater likelihoods of severe injury and death. Rollovers and thus, severe injuries are more likely to occur in rural areas. Attention must be paid to rural, high-speed driving as part of national seatbelt enforcement and education programs.

### *Limitations*

There were several limitations inherent to this study. Due to the design of the PCR, seatbelt use was recorded as "yes"

or "no", with no option to record unknown seatbelt use. As a result, unknown seatbelt use was coded as belt not worn. Such misclassification dilutes the hypothesized, protective effect of seatbelt use, trending it toward the null hypothesis. The protective effects of seatbelt use in this study may be higher than reported if this miscoding has an effect. The deployment of airbag use suffers from similar limitations, and it was difficult to analyze airbag use and its effects on the outcome of the crash in a meaningful fashion. Given that the majority of automobiles in Qatar have airbags, it is likely that their use was not recorded. Thus, it is difficult to separate the protective effects of seatbelt use from those of the airbag, however, airbag use should be equitably distributed among seatbelt and non-seatbelt wearers.

Follow-up of the patients after arrival at the hospital was not feasible, and it is possible that several patients initially categorized as not severely injured, may have decompensated after arrival at the emergency department.

The definition of a case patient was based on variables suggestive of severe injury, but did not depend on an internationally validated injury severity scale. The database did not include Glasgow Coma Scale (GCS) scores, vital signs, or anatomic location of injury. Thus, it was not possible to calculate an Injury Severity Score, Trauma Score, or Prehospital Index—the most generally recognized ratings systems for severity of traumatic injury. The AVPU scale has been used in previous studies as a surrogate for GCS scores. In previous literature median GCS scores associated with AVPU were 15 = Alert, 13 = Verbal, 8 = Pain, and 6 = Unresponsive.[11] In a study attempting to determine mortality in pediatric patients presenting with blunt trauma, unresponsiveness as recorded on the AVPU scale and motor response, recoded as part of the GCS assessment, were predictive of inpatient mortality.[12] The Prehospital Index score, validated by Koehler *et al*, predicts mortality and the need for emergency surgery.[13] This scale relies on blood pressure, pulse, respiratory status, and level of consciousness, each scored on a scale of 1–5. The current study used the AVPU scale to determine level of consciousness; nearly all patients in our cohort had altered mentation; with level of responsiveness being worse than Verbal. Most case patients required airway intervention, with most having absent gag reflexes. Even in the absence of blood pressure and pulse data, such patients would rate 6/20 on the basis of mentation and airway assessment, according to the PHI scale and likely would qualify as "severe" trauma. One limitation of the study was that it identified only the critically ill patients were identified, particularly those with traumatic head injuries. It is likely that this study underestimates the number of patients with severe internal injuries, but with normal mentation not requiring airway management. Thus, the results of this study would not likely be generalizable to the hospital trauma population.

Paramedic observations and reporting of seatbelt use may have been biased by the presence or absence of severe injury. This is an issue raised by Robertson who noted that there is often a bias between reported and actual seatbelt use.[14] Observed belt use among the most severely injured patients, and reported belt use among the less severely injured patients, may lead to an under-reporting of belt use in the control group, and therefore, an overestimation of belt effectiveness. However, Cummings suggests that seatbelt use as reported to police (and presumably paramedics) tends to concur with belt use determined by trained crash investigators.[15]

Another limitation was the selection of patients with minor injuries as the control group. As Robertson notes, if belted patients were uninjured in a crash, and did not require treatment from EMS, it is probable that they would be excluded from the denominator, thus underestimating belt effectiveness.[14] Since of the all victims of an RTC, even those with the most minor injuries, are required to have a PCR filled-out, it is likely that this bias was minimized; however, it is possible that uninjured patients were not fully recorded in the control cohort.

The adjusted odds of severe injury or death in belted patients were 0.51, which compares favorably to previous literature that identified mortality as a primary outcome. These (US) studies, have reported seatbelt effectiveness to be between 40%–50%.[14,16,17]

## Conclusions

Motor vehicle fatalities throughout the Gulf region remain high. Road traffic injuries in Qatar represent a major burden of disease, particularly among young Qataris. Belt use is universally low throughout the nation, despite earlier reported improvements in belt use following a national law and campaign. Prehospital morbidity and mortality appear to be significantly reduced by the consistent use of seatbelts.


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