

# **RESEARCH ARTICLE**

# Pediatric road traffic injuries in Qatar: Evidence for a developmental stage approach to road safety

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http://dx.doi.org/10.5339/qmj.2020.3 Submitted: 27 June 2019 Accepted: 28 August 2019 © 2020 Consunji, Malik, El-Menyar, Mollazehi, Al-Thani, Peralta, licensee HBKU Press. This is an open access article distributed under the terms of the Creative Commons Attribution license CC BY 4.0, which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited.

Cite this article as: Consunji R, Malik S El-Menyar A, Mollazehi M, Al-Thani H, Peralta R. Pediatric road traffic injuries in Qatar: Evidence for a developmental stage approach to road safety, Qatar Medical Journal 2020:3 http://dx.doi.org/10.5339/qmj.2020.3



### ABSTRACT

Road traffic injuries are the leading cause of death in Qatar but their epidemiology in children has not been fully described. This paper will describe the epidemiology of pediatric road traffic injuries (pRTIs) in Qatar, in order to understand the relationships among risk factors, mechanisms of injury, use of safety equipment, and according to child developmental stages.

The primary sample for this study was drawn from all pRTIs (0 – 18 years) from January 2010 to December 2012—motor vehicle occupants, passengers and drivers, pedestrians, cyclists, motorcyclists, and all-terrain vehicle (ATV) drivers and passengers—seen at the trauma registry of the Hamad Trauma Center, the national Level I Trauma Referral Center of Qatar.

During those two years, the Trauma Center attended to 4864 patients, 443 (9.1%) of whom were pRTIs, 83% were male, and 71% were non-Qatari. Only 1.2% of injured passengers and drivers were restrained. All fatalities were passengers or drivers; the overall mortality rate was 3.4%. The motor vehicle crash (MVC) mortality rate was 6.2%, with the longest mean length of hospital stay 10.5 days and highest Intensive Care Unit (ICU) admission rate 35.7%. Older adolescents (15-18 years) comprised 56.4% of total MVC mortality. One-in-four (25%) pedestrian victims was Qatari. They had the lowest mean Injury Severity Score (9.6); 73% were nine years or younger. ATV victims had a 27% ICU admission rate; 48.4% were 10-14 years old. Older adolescents made up only 17% of the pediatric population of Qatar, yet 40% of pRTI victims and 80% of pRTI deaths. Forty-two percent of injured older

adolescents were drivers, with half (21%) of those underage.

There are clear and distinct age and mechanismspecific patterns of pRTIs among children in Qatar that must be used to guide road safety policy and program formulation for underage pedestrians and drivers. Proven interventions that increase seatbelt and child restraint use and graduated driver licensing must be considered.

Keywords: Qatar, road traffic injuries, children, injury prevention, child development

#### **INTRODUCTION**

Injury is one of the leading causes of global mortality and morbidity in pediatric populations and it has been recognized as a rapidly growing global public health threat for children. Worldwide, 40% of all child deaths are attributable to injuries.<sup>1</sup> Despite the fact that more than 90% of the injuries occur in low- and middle-income countries (LMICs), they are also a concern for high-income countries (HICs), where they are the leading cause of childhood death.<sup>2</sup> The majority of child injury deaths are the result of road traffic injuries (RTIs), drowning, burns (fire or scalds), falls, or poisoning. These five injury mechanisms make up 60% of injury fatalities.<sup>2</sup>

Qatar is a high-income, rapidly-developing country with a culturally diverse, growing population and an increasing number of cars and vulnerable road users. Preventative health programs have been effective at reducing child mortality in Qatar. Meanwhile, injuries are expected to surpass congenital and infectious diseases as the leading cause of death for the country's children.<sup>3</sup> In fact, RTIs have been recognized as the leading cause of death for all ages<sup>4</sup> but especially for young males.<sup>5</sup> In an analysis of child injury mortality, Bener et al., reported on 2934 injury deaths in children aged 0 - 18 years. From 1993 to 2007, the leading causes of child injury death in Qatar were RTIs (71.3%), drowning (9.3%), and accidental falls (6%).<sup>6</sup>

Despite the aforementioned studies, the epidemiology of pediatric RTIs (pRTIs) has not been fully described, and there is a marked paucity of published data that describes this public health problem. Injury prevention strategies need to take child development into account as children's needs change dramatically with age and developmental stage.<sup>7</sup> The primary objective of this paper was to describe the epidemiology of moderate-to-severe RTIs that require hospital admission in pediatric patients in Qatar, to document the relationships among risk factors, the different mechanisms of injury, use of safety equipment, and according to child developmental stages.

#### **METHODS**

The primary sample for this study was collected from consecutive data for all pediatric (0 – 18 years) victims of RTI's (motor vehicle occupants, passengers, or drivers) and motor vehicle crashes (MVC), pedestrians (PED), cyclists (BIKE), motorcyclists (MCC), and all-terrain vehicle (ATV) drivers, and passengers. Data was obtained from the trauma registry at the Hamad Trauma Center, the only national Level 1 Trauma Referral Center servicing the entire country, receiving more than 98% of the country's trauma patients.

The trauma registry at the study institution is compliant with both the National Trauma Data Bank and Trauma Quality Improvement Program of the American College of Surgeons Committee on Trauma. It collects data on all activations where mechanisms of injury are consistent with trauma, including all those with International Classification of Diseases, Ninth Revision (ICD-9) codes between 800 and 959.9, and all trauma patients without trauma activation admitted to the trauma service with an ICD-9 code between 800 and 959.9.

Variables collected and analyzed included patient demographics, type and mechanism of injury, safety equipment used, road user type, injury severity score, and total length of stay and outcome. Census data from the Qatar Statistics Authority was used to compute prehospital and in-hospital death rates from RTIs, and as a source for age group population data.

There were no restrictions on study participants based on their location in the country as long as they were under 18 years of age. Excluded from the study were severely injured patients who had died at the scene before arriving to the hospital and those with mild injuries who were treated and discharged from HMC Emergency Department or Primary Health Care Centers.

Descriptive analyses were reported as frequencies and percentages for categorical variables. Continuous variables' central tendency was described using means with standard deviations for variables with normal distribution (as assessed by the Shapiro – Wilk test). Categorical variables were compared using Chi-square test or Z-test of proportions as appropriate. Continuous variables were compared using an independent samples t-test or a Chi-square test, as appropriate. A *p* value of <0.05 (two-sided) was considered statistically significant. All statistical analyses were conducted utilizing the SPSS 21.0 Statistical Package (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.).

Ethical approval for this study was obtained from the Research Ethics Committee, Medical Research Center, Hamad Medical Corporation, Doha, Qatar (MRC # 13146).

#### RESULTS

From January 1, 2010 to December 31, 2012, the Hamad Trauma Center attended to 4864 trauma patients. Four hundred forty-three (9.1%) of these were RTIs affecting children under 18 years old, 83% (n = 367) were males, and 71% (n = 315) were non-Qataris. Most RTIs occurred in the 15 - 18-year-old age group (n = 177, 40%). The distribution of child RTIs in other age groups were as follows: <1 year (n = 4, 1%), 1 – 4years (n = 79, 18%), 5 – 9 years (n = 84, 19%), and 10-to-14 years (n = 99, 22%). The older adolescents, ages 15 - 18 years, were disproportionately represented as victims and the three youngest age groups, 0-9 years, were underrepresented (Figure 1).

Motor vehicle crashes (n = 242, 54%), affecting both drivers and passengers, were the leading

mechanism of child RTIs for all age groups. The other causes of child RTI included: PED (n = 113, 25%), ATV (n = 60, 14%), BIKE (n = 21, 5%), and MCCs (n = 7, 2%; Figure 2).

In the 0-1-year age group, MVCs comprised 75% (n = 3) of RTIs with the remaining 25% (n = 1) due to PED. In the 1 - 4-year group, most injuries affected PED (n = 46, 58%), with MVCs and BIKE causing 39% (n = 31), and 3% (n = 2) of injuries, respectively. The 5–9-years age group had PED (n = 36, 43%) as the leading mechanism followed by MVC (n = 34, 40%), ATV (n = 9, 11%), and BIKE (n = 5, 6%). The distribution of mechanism of injuries in the 10-14-years age group included MVC (n = 38, 39%), ATV (n = 29, 29%), PED (n = 17, 17%), BIKE (n = 13, 13%), and MCC (n = 2, 2%). RTI patients in the 15-18 group had the following RTI mechanisms: MVC (n = 136, 77%), ATV (n = 22, 12%), PED (n = 13, 7%), MCC (n = 5, 3%), and BIKE (n = 1, 1%) (Figure 2).

Utilizing the older adolescents of 15 - 18 years old as a reference age group, statistically significant differences were noted for the proportions of mechanism of injury for all age groups, stippled (Figure 3) (for 0 - 1-year-olds, p < 0.01, for BIKE and MCC. For 1 - 4-year-olds, all p < 0.01, except for BIKE. For 5 - 9-year-olds, all p < 0.01, except for ATV. For 10 - 14-year-olds, all p < 0.01, except for MCC).

The overall in-hospital mortality rate was 3.4% (n = 15). All fatalities were the result of MVCs, whether passengers (33%) or drivers (67%). Eighty-seven percent were Qatari, 80% were 15-18 years old, and just 6.7% were female.



Figure 1. Proportion of Pediatric Population and RTI, by age group, QSA [2010] and HTC [2010-12].



Figure 2. Pediatric RTI Victims by Mechanism of Injury both sexes, ages 0-18, Hamad Trauma Center, Doha, Qatar [2010-12].

All driver mortalities were male with a mean age of 16.4 years. None of the fatalities were documented to have been using a seatbelt or child restraint system.

The MVC mortality rate (6.2%; p = 0.0001) was significantly higher than other mechanisms of injury. MVCs had the longest mean length of stay (10.5 days), the highest ICU admission rate (35.7%) and the majority (56.4%) were adolescents, aged 15–18 years. Only three (1.2%) of the MVC victims were documented to have been using a restraint. One-in-four (25%) PED victims was Qatari. They had the lowest mean Injury Severity Score (9.2) and 56% (n = 63) were 10 years or younger. ATV victims had the second highest ICU admission rate (25%) and nearly half (48.4%) were from 10 to 14 years old. The next rank, 15–18-year-olds, made up only 17% of the pediatric population yet 40% of RTI victims and 80% (n = 12) of RTI deaths were older adolescents. Forty-two percent of them were drivers, half (21%) were underage.

When compared by mechanism of injury, using the MVC victims as the reference population, there were no statistically significant differences noted for mean age and ISS. ATV-related injuries were significantly more likely to need surgical intervention (p = 0.0025) and BIKE-related injuries were less likely to need ICU admission (p = 0.0004), again when compared with MVC victims. Likewise, all mechanisms of pRTI were less likely to succumb to their injuries when compared with MVC victims (Table 1).

Based on 2010–2011 national RTI child mortality statistics, 57 (86%) all pediatric RTI deaths in Qatar occurred in the prehospital setting, i.e., they either died at the scene or during transport to HTC.

#### DISCUSSION

One out of every 11 patients admitted to the Hamad Trauma Center during the study period was a child suffering from a moderate-to-severe RTI. One-in-thirty died as a result of their injuries and, nationally, six out of seven children who died post-RTI did so before arriving at the hospital. Vehicle occupants, passengers or drivers involved in MVCs made up the majority of RTIs and only 1.2% of them were restrained. Forty percent of all victims were young adults aged 15 – 18 years. Half were under the legal driving age, and most had been driving at the time of their accidents. Clear age-related patterns of RTI among these victims stand out. Child occupants were most vulnerable as infants (0-1 year) and as older adolescents, aged 15 – 18. Child pedestrians were most at risk as toddlers, 1-4 years, and young children, ages 5-9. Injuries to cyclists and



Figure 3. Proportion of Road Traffic Injuries, by Mechanism, & Age-Group 0 to 8 years, both Genders, HMC Trauma Registry, Doha, Qatar [2010-12].

Table 1.	Comparison of	key epidemiologic and	clinical characteristics,	, by mechanism	of injury, pediatric
RTIs, 0-	18 years, both	genders, HMC Trauma	Registry, Doha, Qatar	[2010-2012].	

MOI	n	Mean Age [SD] ( <i>p</i> value)	Mean ISS [SD] (p value)	Surgical Intervention n [%] (p value)	ICU Admission n [%] ( <i>p</i> value)	Mortality n [%] ( <i>p</i> value)
MVC BIK	242 21	14.95 [4.31] 9.86 [3.79] (0.3752)	11.39 [11.56] 7.64 [2.8] (0.7526)	61 [25.2] 6 [28.6] (0.7457)	86 [35.7] 2 [9.52] (0.0004)	15 [6.2] 0 [0] (0.0001)
PED	113	11.16 [5.69] (0.5954)	9.64 [6.57] (0.8953)	25 [22.1] (0.5198)	36 [31.86] (0.51)	0 [0] (0.0001)
ATV	60	14.63 [4.12] (0.9572)	11.36 [7.19] (0.9982)	27 [45] (0.0025)	16 [26.67] (0.1812)	0 [0] (0.0001)
МСС	7	16.28 [1.66] (0.7734)	12.37 [6.36] (0.9408)	4 [57.1](0.0574)	1 [14.29] (0.1486)	0 [0] (0.0001)

Motor vehicle crash [MVC] patients, both passengers and drivers, were the reference population, values in boldface and underlined have a statistically significant difference from the MVC population. n - number of patients, SD - standard deviation, RTIs - road traffic injuries, ICU - intensive care unit.

ATV riders were most common among adolescents, ages 10 - 14.

In the UAE, the leading mechanisms of RTIs in the pediatric population, from 2006-2007 were, MVCs (70%), PED (15%), MCC (9.6%), and BIKE (4.6%).<sup>9</sup> In Saudi Arabia, RTIs were among the leading causes of head injuries in children: MVC's (34.2%) were the most common cause, followed by PED injuries (30.3) and MCC (2.3%).<sup>10</sup> These are comparable to our results with the following leading causes of RTI's in decreasing order: MVCs (54%), PED (25%), ATVs (14%), BIKE (5%), and MCC (2%). However, the leading mechanisms of RTIs differed in France where a 2006 study involving children who suffered fatal or severe road traffic injuries there showed PED and BIKE (66%) as the leading victims, followed by MVCs (34%).<sup>11</sup> This suggests that increased child car restraint usage rates, such as in France or other HICs, lead to reductions in child passenger injuries in MVCs. Additionally, all 50 states in America have child passenger safety laws, and 48 states have booster seat laws. As a result, child passenger fatalities from MVCs have declined since the 1990s for children 0-15 years old in the United States. From 2002 to 2011, motor vehicle death rates for children 0-12 years old decreased by 43%. Child restraint systems have been found to decrease fatal injuries by 71% for infants younger than one year and 54% for toddlers 1 – 4 years old.<sup>12</sup>

In two previous studies from Qatar, none of the pediatric trauma patients from 0 to 18 years of age or any from 0 to 4 years were reported to be using child restraint systems.<sup>13–14</sup> While we acknowledge that the trauma registry did not uniformly capture all data on restraint use, we can report a marginally

higher restraint usage of 1.2%. These usage rates were considerably lower than those reported for adult trauma patients in Qatar (33%)<sup>15</sup> and front seat passengers by the Ministry of Interior in 2010 (50%).<sup>12</sup> At present, the only law pertaining to child passengers in Qatar prohibits those under the age of 10 from riding in the front seat. For adults, only front row passengers are required to use seat belts. Expanding these present laws to require seat belt use by all passengers and legislation for all child occupants have been clearly shown to reduce the incidence of severe injuries and deaths while increasing child restraint use.<sup>11</sup> To provide further evidence to support the implementation of a comprehensive child passenger restraint law in Qatar, the authors of this paper are key investigators on a National Priorities Research Program Grant from Qatar National Research Fund a member of Qatar Foundation (http://www.gnrf.org/en-us/Funding/Research-Programs/National-Priorities-Research-Program-NPRP), "NPRP No. 7 - 1681 - 3 - 429: Young Kids In Safe Seats (Y-KISS) - Qatar Program: A Randomized Study to Increase Child Restraint Use in Qatar." The study compares two interventions designed to improve car restraint use by young children, ages 0-5, by consulting at well-baby clinics in Doha. It is hoped that the combination of these efforts will contribute evidence to the effort to hasten the passage of much needed laws requiring restraint use for all vehicle occupants in Qatar.

The most common mechanism of pediatric RTIs in the different age groups from Qatar, revealed a slightly different trend when compared with the UAE. A study from the UAE reported MVCs to be the most common mechanism of RTIs in the 0-4 age group

(57.5%), PED (33.3%), and BIKE (6%).<sup>8</sup> In Qatar, the most common mechanism of RTI for this age group was PED (57%), followed by MVC (41%), with very few BIKE injuries (2%). In the 5–9-years age group, PEDs were the most commonly injured in both countries, but by a much larger margin in the UAE, compared with MVC's (PED (57.1%) and MVC (39.2%) there. Residents of Qatar, 10-14 years old, were most likely to be injured in an MVC, similar to those in the UAE, but markedly more children were injured as ATV riders. Finally, among the oldest age group, MVC was the leading mechanism in both countries, with ATV's the second leading cause in Oatar and MCC in the UAE. Regardless of the differences noted, both countries demonstrate the age-specific nature of the leading mechanisms of RTI with child passenger restraint use declaring itself as the leading road safety priority for children of all ages.

Eighty-three percent of the patients in our study were male and 17% were female. This marked difference between genders is consistent with findings from the UAE where males constituted 79% and females just 21%.<sup>8</sup> In Panama, in a 2012 study of child MVC victims, females contributed 47% and males 53% of the total number of victims.<sup>16</sup>

Another important statistic that came to light was that in both Qatar and the UAE, the majority of injured patients were in the 15–18-year age group, there was a striking difference when it came to the nationalities of children affected by RTIs. In Qatar, 29% of the injured were Qataris and the other 71% were non-Qataris, whereas in the UAE, 67% were UAE nationals and 33% expatriates.<sup>8</sup>

The majority of in-hospital pRTI deaths in Qatar affected older adolescent males who were more likely to be Qatari nationals. Underage driving was a major risk factor. This phenomenon has been previously reported and was the focus of a November 2015 workshop in Doha, convened by the Ministry of Interior during the 24<sup>th</sup> World International Traffic Medicine Association Congress. Of greater concern is that the overwhelming majority (86%) of pRTI deaths in Qatar occur in the prehospital setting. This fact highlights the need for more effective and proven primary prevention efforts, based on crash investigations linked with mortuary and ambulance data.

The current study demonstrates that there are statistically significant differences in the mechanisms

of RTI between age groups. Clearly, one size does not fit all for the road safety of children in Qatar. Pedestrian injuries were most common in toddlers (1 - 4 years old) and older children (5 - 9 years old). Children in these groups are not equipped with the neurodevelopmental skills to make them safe as unaccompanied pedestrians.<sup>2</sup> Therefore, there is a need for targeted, proven, and effective pedestrian safety education and awareness programs for families and caregivers with young children, and the creation of safe zones for young pedestrians around schools, homes, and residential compounds for the improvement of child pedestrian safety in Qatar.

For older children, ages 5 – 14 years, where BIKE and ATV injuries were more common, families must recognize these "gateway" injuries that presage the RTIs that affect the older age group. Underage drivers riding in unsafe locations, e.g., ATVs on the streets, nonuse of helmets, and restraints have all been identified as risk factors for RTIs. Children make up 20% of all ATV RTIs in Qatar.<sup>17</sup> Programs that will prohibit ATV rentals to underage and untrained drivers, require helmets and/or restraint use by all BIKE and ATV operators, and identify ATV-only areas, will provide targeted RTI prevention for this age group.

We found the majority of RTIs and mortalities affected male underage drivers. This did not differ from findings from the Gulf region<sup>17</sup> to the US,<sup>18</sup> and it echoes the calls for proven interventions to save lives from this very young and potentially productive population. This same age group has also been noted to be disproportionately ejected and injured in rollovers in Qatar, which make up 40% of all RTIs treated at HTC.<sup>19</sup> Many of the proven interventions to prevent rollover RTIs, such as requiring electronic stability controls and side curtain airbags for offroad vehicles, are well-known. They have been described elsewhere and should be implemented in Qatar.<sup>20</sup>

Lastly, and most importantly, poor compliance with proven and effective interventions among this age group in Qatar has been well documented,<sup>20</sup> yet the response is inadequate. This highlights the need to stop implementing unproven interventions, such as young driver education that has been shown to increase their risk for involvement in crashes,<sup>21</sup> and in their stead implement proven ones such as graduated driver licensing, a step-wise approach to licensing that imposes a supervised and restricted probationary period prior to granting of full, independent privileges.<sup>22</sup>

Road safety stakeholders need to continue emphasizing best practices for child passenger safety for all ages. The proper use of age- and size-appropriate child restraint systems is a clear priority for child road safety in Qatar. Authorities must inform families and caregivers that young children, below the age of nine, need adult supervision while using the road as pedestrians. That must be a basic safety message for all. ATVs are not toys, children below the age of 12 should not be allowed to use them, and proper training and equipment, e.q., helmets and goggles, must be required for all ATV users in Qatar. Young and underage drivers, and their families, must be made the focus of graduated driver licensing programs and consistent enforcement of existing rules for restraint use. This enforcement must persist throughout the entire life cycle of all residents of Qatar.

#### Limitations

The application of retrospective sampling using a registry that was not purposely designed to collect data on pRTIs allows for a number of limitations that one might expect, primarily incomplete data with insufficient details. Similarly, data on mild and moderate pRTIs that did not require admission or treatment at a Trauma Center, or victims dying at the scene, were not captured in this analysis. Lastly, data that describes the social, environmental or even cultural circumstances of each pRTI was not available. Such information would be very useful to better inform the creation of targeted child road safety programs that will be culturally, linguistically, and mechanism-specific.

#### CONCLUSIONS

RTIs affecting children in Qatar require immediate actions that are proven to be effective and appropriate for each stage of their development. Road safety education must be focused on the highest risk of each age group because a "one size fits all" approach is not one supported by our findings. Knowledge of the age and mechanism-specific patterns of RTIs involving Qatari children is essential to guiding this policy formulation and its implementation.

#### FUNDING

Financial support was provided for this grant from the Medical Research Center, Hamad Medical Corporation, Doha, Qatar (MRC # 13146).

#### **CONFLICTING INTERESTS**

None.

#### ETHICAL APPROVAL

Ethical approval for this study was obtained from Research Ethics Committee, Medical Research Center, Hamad Medical Corporation, Doha, Qatar (MRC # 13146).

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