Increased morbidity associated with weekend paediatric road traffic injuries: 10-year analysis of trauma registry data

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ABSTRACT

Background: Road traffic injuries (RTIs) are a significant cause of paediatric morbidity and mortality worldwide, with a disproportionate number of these injuries occurring in lowand middle-income countries (LMICs). Adult data from LMICs suggest that weekends are particularly high-risk for RTIs, but whether children are at increased risk of RTI on weekends has not previously been investigated in any setting. This study sought to assess patterns in paediatric RTI presentations using hospital-based trauma surveillance data in Cape Town, South Africa.

Methods: Data was analysed from Chisafae South Africa’s prospectively collected trauma registry for injured children below 13 years of age presenting to a tertiary paediatric referral Trauma Department between 2004 and 2013.

Results: During the 10-year study period, a total of 71,180 patients presented with traumatic injuries, of which 8,815 (12.4%) resulted from RTIs. RTI patients had a mean age of 5.2 ± 3.6 years, and were predominantly males and pedestrians. RTIs were more common on weekends than weekdays (2.98 vs. 2.19 patients/day, p < 0.001), representing a greater proportion of daily all-cause trauma (15.5% vs. 11.2%, p < 0.001). Moreover, weekend RTI patients sustained more severe injuries than on weekdays, and compared to weekend all-cause trauma patients (injury score 1.66 vs. 1.46 and 1.43, both p < 0.001), RTI patients were more likely to require admission to both the trauma ward (1.14 vs. 0.79 patients/day, p < 0.001) and the PICU (0.10 vs. 0.07 patients/day, p < 0.05) on weekends than on weekdays. Weekend RTI patients most frequently required admission to the trauma ward (p < 0.001) and the PICU (p < 0.05) during the last annual quarter.

Conclusions: In a LMIC-setting, paediatric RTI patients are more frequently brought to medical attention, sustain more severe injuries and more frequently require hospital admission during the weekend. These findings highlight the importance of trauma surveillance data to inform targeted community prevention strategies for improving child road safety.

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Presenting to a South African Trauma Department, representing 16% of all injuries and 25% of all admissions [3].

Targeted injury prevention strategies are necessary to reduce the human and societal burden of childhood RTIs. Several interrelated factors place children at particular risk for RTI: physical and developmental, socioeconomic and environmental, vehicle and safety equipment-related [1]. Injury prevention programming requires an understanding of these risk factors to direct resources towards interventions that are likely to have the greatest impact. Studies are needed to inform prevention strategies for improving child road safety and optimizing clinical trauma care. Examples of successful evidence-based interventions include child roadside skills programs [4], speed reduction measures [5], and enforcement of road safety regulations [6]. To this end, trauma registry data can help identify modifiable risk factors amenable to risk reduction.

Previous paediatric surveillance data in LMICs suggest that all-cause trauma mortality is higher on weekends and holidays [7]. However, to our knowledge, no study has previously described temporal patterns of paediatric RTIs in any setting. We hypothesized that children in a LMIC setting are at increased risk of RTI on weekends compared to weekdays. We undertook a 10 year retrospective analysis of hospital-based trauma surveillance data with the specific aims of (1) describing weekend trends in paediatric RTI presentations, and; (2) identifying high-risk weekdays and weekends for paediatric RTI-related hospital admissions and death.

Methods

This single centre retrospective cohort study utilized prospectively maintained hospital trauma registry data collected by the Childsafe South Africa as described previously [3]. This database is comprised of all injured patients presenting to the Red Cross War Memorial Children’s Hospital (RCCH). RCCH is a nationally funded, tertiary paediatric referral hospital that serves children less than 13 years of age from the city of Cape Town and the surrounding Western Cape province of South Africa. The Emergency Department has a census of 31,000 annual visits, which includes more than 7000 cases presenting to the dedicated level-1 Trauma Department. The study population included all children captured by the RCCH database presenting to the Trauma Department with an RTI during the 10-year period between January 2004 and December 2013. Data extracted from the trauma database included patient age, gender, date of injury, mechanism of injury, abbreviated injury score (AIS), and disposition from the Trauma Department. A total of 1108 patients (1.6%) were excluded from the analysis for age because of missing age data. RTI mechanisms included injured pedestrians, motor vehicle or minibus passengers, cyclists and motorcyclists. Injury severity was established following full assessment of the child by the Trauma Department attending clinician using RCCH’s four-point AIS of ‘mild’, ‘moderate’, ‘severe’ and ‘death’, as described previously [3]. ‘Mild’ injuries require only minor treatment and result in discharge on the day of presentation. ‘Moderate’ injuries include those requiring admission, wounds requiring closure or another procedure, all fractures, and all minor and intermediate head injuries. ‘Severe’ injuries are those necessitating resuscitation or paediatric intensive care unit (PICU) care, all polytrauma patients, all patients presenting signs of shock, and all severe head injuries. ‘Death’ includes all injuries resulting in mortality in the Trauma Department. Disposition from the Trauma Department was defined as either admission to the RCCH trauma ward, admission to the PICU, discharged from or died in the Trauma Department. Weekend was defined as patients presenting between Saturday 00H00 and Sunday 23H59. Yearly quarters were defined as consecutive 13-week intervals. All surveillance data was first entered onto a Microsoft Excel spreadsheet (Microsoft Corporation, 2011) from the original patient charts. Statistical analysis was conducted using GraphPad Prism v.6.03. Categorical variables are expressed as proportions and were analysed by Chi-square testing. Continuous variables are expressed as mean ± SD; weekend versus weekday data were analysed using a paired student t-test, quarterly data were analysed using a repeated measures ANOVA followed by Bonferroni-corrected post-testing for individual mean differences when ANOVA revealed a significant group effect. A two-tailed P-value < 0.05 was considered statistically-significant. The study was approved by the Research Ethics Board of the University of Cape Town, South Africa.

Results

Annual trends in RTI presentations

During the 10-year study period, a total of 71,180 patients were treated at RCCH for all trauma-related injuries, among which 8815 (12.4%) were RTI patients (Table 1). RTI patients had annual mean ages ranging from 5.0 to 5.5 years and were predominantly male. The majority of RTI victims were pedestrians, and only a minority of vehicle occupants were restrained passengers. In all years of study, mean RTI injury severity (AIS) was consistently greater than mean all-cause trauma severity (p < 0.001). The annual proportion of RTI patients admitted to the trauma ward steadily decreased throughout the study period (51.0% vs. 22.1%, p < 0.001), whereas RTI patients requiring admission to the intensive care unit varied within the range of 1.4%–5.4%. Overall Trauma Department mortality secondary to RTI was uncommon, with a total of 24 deaths over the 10-year study period (range 0–6 per year, data not shown).

Weekend versus weekday trends in RTI presentations

Daily volume for all-cause trauma patients did not differ by day of the week (p = 0.39, Fig. 1), however RTI patients presented more frequently on weekends than on weekdays (2.98 ± 0.38 vs. 2.19 ± 0.12 RTI patients/day, p < 0.001). Consequently, RTI victims represented a greater proportion of all-cause trauma patients on weekends compared to weekdays (15.5 ± 1.7% vs. 11.2 ± 1.1%, p < 0.001). In terms of injury severity (Fig. 2), mean AIS was higher for RTI patients presenting on weekends compared to those presenting on weekdays (1.66 ± 0.04 vs. 1.46 ± 0.07, p < 0.001), and similarly higher than the mean AIS for weekend all-cause trauma patients (1.43 ± 0.05, p < 0.001). In terms of admissions (Fig. 3), RTI patients more frequently required admission on weekends compared to weekdays, both to the trauma ward (1.14 ± 0.32 vs. 0.79 ± 0.19 patients/day, p < 0.001) and to the PICU (0.10 ± 0.04 vs. 0.07 ± 0.03 patients/day, p < 0.05). Comparatively, admission of all-cause trauma patients was not increased to either the trauma ward or the PICU on weekends compared to weekdays (data not shown).

Yearlong weekend RTI presentations

After identifying the important contribution of weekends to overall RTI volume, we analysed longitudinal trends in weekend RTI presentations throughout the calendar year (Fig. 4). The year was divided into 13-week quarters to assess seasonal patterns. Quarterly patterns of weekend RTI presentations are summarized in Table 2. Overall, weekend RTI severity was consistent throughout the year, and AIS did not differ between quarters (p = 0.66). There was however, a seasonal pattern in weekend RTI patient volume (Fig. 4A), with the fewest RTI patients presenting on weekends during the second quarter of the year (p < 0.05), and the greatest number of RTI patients presenting during the last
quarter \((p < 0.05)\). Moreover, in the last annual quarter, the greatest number of RTI patients required admission to both the trauma ward \((p < 0.001, \text{Fig. 4B})\) and the PICU \((p < 0.05, \text{Fig. 4C})\).

### Discussion

Our study sought to describe temporal patterns of paediatric RTIs using a large, prospectively collected LMIC hospital trauma registry. We have shown that paediatric RTI patients are more frequently brought to medical attention, sustain more severe injuries and more frequently require hospital admission during weekends compared to weekdays. Weekends during the last annual quarter appeared to be particularly high-risk, with the greatest number of RTI presentations and admissions to both the trauma ward and the PICU. RTI patients were predominantly young males, and the majority were pedestrian-related injuries. These findings should be considered in the context of systems-based hospital organization and indicate potential for targeted community prevention strategies.

To date, no other study has described the temporal patterns of paediatric RTIs, in a LMIC setting or otherwise. Our findings are consistent with recent data from the Western Cape of South Africa on RTI-related fatalities. A 2011 report by the Center for Transport Studies, under the mandate of the Provincial Government of the

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### Table 1

Patients demographics over 10-year study period.

<table>
<thead>
<tr>
<th>Year</th>
<th>N</th>
<th>AIS</th>
<th>RTI Patients</th>
<th>RTI Admissions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>N (%)</td>
<td>AIS</td>
</tr>
<tr>
<td>2004</td>
<td>6258</td>
<td>1.52 (0.56)</td>
<td>813 (13.0)</td>
<td>1.65 (0.62)</td>
</tr>
<tr>
<td>2005</td>
<td>6600</td>
<td>1.43 (0.58)</td>
<td>947 (14.3)</td>
<td>1.58 (0.63)</td>
</tr>
<tr>
<td>2006</td>
<td>5956</td>
<td>1.39 (0.53)</td>
<td>785 (13.2)</td>
<td>1.48 (0.59)</td>
</tr>
<tr>
<td>2007</td>
<td>6918</td>
<td>1.40 (0.53)</td>
<td>874 (12.6)</td>
<td>1.50 (0.59)</td>
</tr>
<tr>
<td>2008</td>
<td>6839</td>
<td>1.37 (0.52)</td>
<td>936 (13.7)</td>
<td>1.47 (0.61)</td>
</tr>
<tr>
<td>2009</td>
<td>7591</td>
<td>1.42 (0.53)</td>
<td>943 (12.4)</td>
<td>1.48 (0.62)</td>
</tr>
<tr>
<td>2010</td>
<td>7916</td>
<td>1.42 (0.54)</td>
<td>947 (12.0)</td>
<td>1.46 (0.59)</td>
</tr>
<tr>
<td>2011</td>
<td>8088</td>
<td>1.42 (0.56)</td>
<td>938 (11.6)</td>
<td>1.49 (0.61)</td>
</tr>
<tr>
<td>2012</td>
<td>7529</td>
<td>1.44 (0.56)</td>
<td>810 (10.8)</td>
<td>1.54 (0.67)</td>
</tr>
<tr>
<td>2013</td>
<td>7485</td>
<td>1.45 (0.56)</td>
<td>822 (11.0)</td>
<td>1.54 (0.61)</td>
</tr>
<tr>
<td>Mean</td>
<td>7118</td>
<td>1.43 (0.57)</td>
<td>882 (12.4)</td>
<td>1.52 (0.60)</td>
</tr>
</tbody>
</table>

AIS = Abbreviated Injury Score, PICU = Paediatric Intensive Care Unit, RTI = Road traffic injury; Data are presented as mean (SD) or percent where indicated;

\( ^a \) \(p < 0.001\) 2013 vs. 2004

\( ^b \) \(p < 0.001\) RTI vs. All Trauma Patients

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### Notes

**Fig. 1.** Mean ± SD daily volume of all-cause trauma patients (black line, left axis) and RTI patients (grey line, right axis); ***\(p < 0.001\) weekend vs. weekdays.

**Fig. 2.** Mean ± SD abbreviated injury score for all-cause trauma patients (black line, left axis) and RTI patients (grey line, right axis) by day; ***\(p < 0.001\) weekend vs. weekdays, \( ^{1,2}p < 0.001 \) All-cause trauma patients vs. RTI patients.

**Fig. 3.** Mean ± SD number of RTI patients requiring admission to the trauma ward (black line, left axis) and the PICU (grey line, right axis) per day; **\(p < 0.05\)** PICU weekend vs. weekdays, ***\(p < 0.001\) Trauma Ward weekend vs. weekdays.
Western Cape, found more fatal RTIs on weekends, with more than 220 fatal Saturday RTIs annually, compared to less than 60 occurring on Wednesdays [8]. Similarly, an analysis of all 2014 RTI fatalities by the Department of Transport and Public Works of the Western Cape Government identified 13.75 road deaths on weekends compared to just 2.47 on weekdays [9]. Both of these reports on RTIs in the Western Cape assessed only pre-hospital mortality, and paediatric outcomes were not specifically assessed.

The finding in our study that RTI patients tend to be more severely injured and requiring admission on weekends has important implications for hospital system preparedness. A number of studies have shown higher morbidity and mortality among patients admitted on weekends [10–12]. Paediatric patients undergoing urgent surgical procedures during weekend admissions have been found to be at greater risk of death, blood transfusion, and procedural complications [11]. Adult studies have

**Table 2**

Quarterly patterns in weekend RTI presentations.

<table>
<thead>
<tr>
<th></th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>Overall ANOVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIS of weekend RTI patients</td>
<td>1.53 (1.11)</td>
<td>1.57 (0.11)</td>
<td>1.58 (0.17)</td>
<td>1.58 (0.09)</td>
<td>*p = 0.66</td>
</tr>
<tr>
<td>Number of RTI patients/weekend</td>
<td>7.13 (1.14)</td>
<td>5.35a (0.80)</td>
<td>6.48 (0.80)</td>
<td>8.44b (1.18)</td>
<td>*p &lt; 0.001</td>
</tr>
<tr>
<td>RTI trauma ward admissions/weekend</td>
<td>2.49 (0.21)</td>
<td>2.14 (0.96)</td>
<td>2.38 (0.66)</td>
<td>4.11c (0.61)</td>
<td>*p &lt; 0.001</td>
</tr>
<tr>
<td>RTI PICU admissions/weekend</td>
<td>0.13 (0.13)</td>
<td>0.17 (0.12)</td>
<td>0.19 (0.08)</td>
<td>0.47d (0.25)</td>
<td>*p &lt; 0.001</td>
</tr>
</tbody>
</table>

AIS = Abbreviated Injury Score, PICU = Paediatric Intensive Care Unit, RTI = Road traffic injury.

Data are presented as mean (SD).

a * p < 0.05 vs. Q1, Q3 and Q4.

b * p < 0.05 vs. Q1, Q2 and Q3.

c * p < 0.001 vs. Q1, Q2 and Q3.
suggested that weekend admissions to the intensive care unit have been associated with higher morbidity and mortality [12,13]. Smith et al. found a 48% increased mortality risk among patients admitted on public holidays [14]. Our study found a higher volume of patients requiring admission during the last annual quarter, a period that coincides with public holidays.

Several authors have advocated for the use of trauma surveillance data for the development of targeted injury prevention programs [15–18]. In a trauma registry review of 1.874 patients admitted to a tertiary care paediatric trauma centre between 2004–2006 (including 32% RTIs), Rogers et al. identified that most injured children were not wearing proper injury prevention devices [18]. This finding led to standardized safety counselling and intensified public awareness efforts to augment use of injury prevention devices. As seen in our population, pedestrian RTIs are a markedly overrepresented mechanism of injury worldwide [1]. A review of RTIs in Ghana helped identify critical locations to focus pedestrian safety efforts [5]. Data from the present study similarly suggest that targeted strategies to increase pedestrian safety during high-risk weekends may be high yield to reduce paediatric RTIs.

Trauma surveillance data may additionally serve as an indicator of the efficacy of trauma prevention initiatives. In a South African study of all-cause paediatric trauma from 1997–2006, RTI similarly represented 16% of all injuries, and only 23.8% of patients were restrained [3]. Overall, our study found a 19.8% rate of child restraint usage among RTI patients in the 10-year study period from 2004–2013. Taken together, these data suggest that minimal progress has been made to encourage the use seatbelts for child passengers in the Western Cape in nearly two decades. Despite national seat-belt laws in South Africa, a WHO estimate of national seat-belt usage in 2010 was 31% among front-seat passengers, down from 67% in 2009 [19]. There is an urgent need to address the low level of adherence and enforcement of child restraint laws in South Africa [20] and among other LMICs [21].

Some limitations of the present study reflect the nature of retrospective database studies. The trauma registry database analysed was designed to prospectively capture injured children presenting to the Trauma Department. The database does not follow admitted patients throughout their hospitalization trajectory. As such, outcomes such as hospital length of stay and mortality during admission are not tracked. Overall injury severity was assessed in all patients prospectively using the RCCH 4-point AIS [3], which differs from the frequently-used, anatomically-based 6-point injury scoring system developed by the Association for the Advancement of Automotive Medicine [22,23]. While we observed an association of weekend RTIs with greater injury severity necessitating admission, hospital admission as an outcome measure may be affected by multiple patient, pre-hospital and hospital-intrinsic variables [24]. We report a greater number of RTIs on weekends during the last annual quarter. This period correlates with public holidays and increased road travel in most countries, however these seasonal RTI trends may not be generalizable to geographic areas where weather and road conditions differ. Our definition of weekend was restricted to Saturday and Sunday, and thus injured children presenting on Friday evening or after midnight on Sunday would not have been captured [25]. Additionally, we have included RTI patients among ‘all trauma patients’ and ‘all-trauma cause’ injury severity calculations. These definitions would only tend to bias our study’s results towards the null; the actual differences of weekend RTI severity and volume could be greater than what we report. Finally, our study does not allow us to determine the root causes for increased weekend paediatric RTIs, which are likely multifactorial.

Despite these limitations, findings from this large, 10-year study are the first to identify weekends as high-risk for paediatric RTIs. Our study emphasizes the importance of trauma surveillance data to inform targeted community prevention strategies. Increased morbidity from weekend paediatric RTIs could have important implications for system-wide resource allocation, particularly in LMIC settings. Defining cost-effective systems for improving road safety for children in LMIC during these high-risk times remains an important area of future research.

Conflicts of interest

No conflicts of interest or financial disclosures

Meeting

Abstract accepted to the 17th European Congress of Trauma & Emergency Surgery, the Trauma Association of Canada 2016 Annual Scientific Conference, and the Society for Academic Emergency Medicine 2016 Annual Scientific Meeting

Acknowledgments

The authors thank Childsafe South Africa for supplying the data from their Child Trauma Surveillance System.

References


