

Back-over Collisions in Child Pedestrians from the Canadian Hospitals Injury Reporting and Prevention Program

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Objective: The objective of the current study was to describe the burden of back-over collisions within the context of other child pedestrian collisions as identified through a pediatric emergency room injury surveillance database.

Methods: Injury data for child pedestrian motor vehicle collisions from 1994 to 2003 were obtained from the Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP). Back-over collisions involving children under the age of 14 were identified and classified by written narratives. Characteristics of children involved in back-over collisions were described, and for those admitted to hospital, the nature of injury was compared with other types of child pedestrian collisions.

Results: There were 4295 child pedestrian motor vehicle collisions reported to CHIRPP during the study time period. Of the 4295 children, 148 (3.4%) were injured in a back-over collision, with 49 (33.1%) of these collisions involving a vehicle backing out of a driveway. Children involved in back-over collisions were significantly younger than those in forward-moving/other collisions; however, almost 50 percent of back-over collisions involved children older than age 4. Children involved in back-over collisions on driveways were significantly younger than those involved in collisions occurring at other locations. Of those admitted to hospital, children in back-over collisions were more likely to sustain injuries to internal organs. Children in back-over collisions were less likely to sustain severe/mild head injuries and hip/leg fractures.

Conclusions: Although back-over collisions represent a small proportion of pedestrian motor vehicle collisions, they tend to involve more severe injuries, as indicated by their admission to hospital. It was found that older children are also at risk of back-over collisions and back-over collisions occur in areas other than driveways. In order to lessen the burden of back-over collisions, interventions must address children of different ages and a variety of locations.

Keywords Back-over; Child pedestrian; Motor vehicle collision; CHIRPP

INTRODUCTION

Pedestrian injuries in children are a major cause of traumatic death. In Canada, pedestrian injury is among the three leading causes of injury death in children, along with drowning injury and motor vehicle occupant injury (Safe Kids Canada 2006). Child pedestrian fatalities account for a large proportion of all road user fatalities, with more than quarter of those involved under the age of 4 (Transport Canada, Road Safety and Motor Vehicle Regulation 2004).

Child pedestrian deaths commonly involve non-traffic situations, and most occur at low speeds (or in low-severity crashes) (Brison et al. 1988). Low-speed collisions involving vehicles backing over (henceforth referred to as back-over collisions) have become more of a concern due to the popularity of sport utility vehicles (SUVs), which tend to have larger blind spots (Fenton et al. 2005; National Highway Traffic Safety Administration [NHTSA], US Department of Transportation 2008). A study of fatal pedestrian injuries in Washington State found that two thirds of non-traffic fatalities involved back-over collisions (Brison et al. 1988). In an 11-year Australian study, it was found that 57 percent pedestrian deaths were the result of a back-over collision (Robinson and Nolan 1997). The literature has consistently reported that younger children (ages 0 to 5) are most frequently involved in back-over collisions (Brison et al. 1988; Fenton et al. 2005; Nadler et al. 2001;

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Silen et al. 1999; Winn et al. 1991). The majority of research in this area has focused specifically on back-over collisions that occur on driveways (Fenton et al. 2005; Holland et al. 2000; Nadler et al. 2001; Patrick et al. 1998; Roberts et al. 1995). A modest amount of literature has been written addressing back-over collisions in other locations. There is also limited research available comparing the characteristics of back-over collisions to other types of nonoccupant collisions. A study by Patrick et al. (1998) compared these two collision scenarios, although the analysis was limited to two trauma centers and specifically focused on driveway-related back-over trauma. A strong understanding of the environment where back-over collisions take place and characteristics of the children involved is required in order to develop a comprehensive strategy for the prevention of these collisions.

The objective of the current study was to describe the burden of back-over collisions within the context of other child pedestrian collisions as identified through a pediatric emergency room injury surveillance database.

METHODS

Injury data for this study were obtained from the Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP) database, administered by the Public Health Agency of Canada. CHIRPP is an injury-surveillance program that collects both incident and injury information from emergency rooms in ten pediatric hospitals and four general hospitals in Canada. The CHIRPP data set classifies injuries by both body region and nature of the injury. CHIRPP data has been found to be reliable and valid (Macarthur and Pless 1999). It has also been found to represent the Canadian youth injury experience (Pickett et al. 2000).

The sample for this study included nonoccupant (i.e., pedestrian) motor vehicle collisions occurring between September 1994 and December 2003, which involved Canadian children between the ages of 0 and 13 years. Other nonoccupant collisions, such as collisions involving bicycles, were excluded from this study. Injuries were classified as resulting from a back-over

or forward-moving/other collision based on written narrative in the "what happened" field. Collision cases containing the words *back*, *reverse*, *rear*, *rollover* (in the context of a car rolling onto a child) in the written narrative were identified, reviewed, and further classified as back-over collisions. As the data also included French narratives, words, phrases, or parts of the words, including *reculer*, *arrière*, *inverser*, *à rebours*, and *pile*, were also searched. Narratives that did not include the above terms were classified as forward-moving/other cases. All cases that identified a vehicle as backing out of a driveway, in either the CHIRPP coding or in the written narrative, were classified as "driveway" collisions; if there was no mention of the term *driveway* or identification of an alternative location, the cases were then classified as non-driveway/unspecified back-over collisions.

Statistical analyses were conducted using SPSS (SPSS 2006). Chi-square statistics were calculated to examine characteristics involved in different types of child pedestrian collisions. A subset of children admitted to hospital (i.e., the most severe injuries) was analyzed by type of collision to assess differences in injury profiles. This study was approved by the Hospital for Sick Children's Research Ethics Board in November 2006.

RESULTS

There were 4295 child pedestrian motor vehicle collisions reported to CHIRPP between 1993 and 2004. Table I describes the characteristics of pedestrian motor vehicle collisions in the CHIRPP data set. Of the total number of collisions, 148 (3.4%) were back-over collisions. The age distribution between back-over and forward-moving/other crash types was significantly different ($\chi^2 = 96.66$; $p = 0.000$), with younger children more likely involved in back-over collisions. Fifty percent of back-over collisions involved children older than 4 years old, 32 percent between the ages of 5 to 9 years, and 16 percent between the ages of 10 to 14 years.

There was no significant difference in the gender distribution between back-over and forward-moving/other crashes. There was a significant difference found in the type of treatment received between the two groups, with children involved

Table I Characteristics of pedestrian-motor vehicle collisions in CHIRPP data set.

Characteristics	Forward-moving/other collisions $N = 4147$ (96.6%), N (%)	Back-over collisions $N = 148$ (3.4%), N (%)	Driveway back-over collisions ^a $N = 49$ (33.1%), N (%)	Non-driveway back-over collisions ^a $N = 99$ (66.9%), N (%)
Age groups*				
<1	33 (0.8)	1 (0.7)	0**	1 (1.0)
1-4	775 (18.7)	76 (51.4)	34 (69.4)	42 (42.4)
5-9	2061 (49.7)	48 (32.4)	10 (20.4)	38 (38.4)
10-13	1278 (30.8)	23 (15.5)	5 (10.2)	18 (18.2)
Male	2571 (62.0)	98 (66.2)	36 (73.5)	62 (62.6)
Treatment received**				
No medical treatment	798 (19.3)	22 (15.0)	4 (8.2)	18 (18.4)
Treatment at hospital, no admission	1983 (47.8)	61 (41.5)	24 (49.0)	37 (37.8)
Admitted to hospital	1346 (32.5)	64 (43.5)	21 (42.9)	43 (43.9)
Dead on arrival	18 (0.4)	0	0	0

^aThese categories are subsets of those children involved in back-over collisions.

* $p \leq 0.001$. ** $p \leq 0.05$.

Table II Most commonly reported injuries in children admitted to the hospital by collision type and distribution.

Nature of injury	Forward-moving/other collisions <i>N</i> = 4148 (96.6%), <i>N</i> (%)	Back-over collisions <i>N</i> = 147 (3.4%), <i>N</i> (%)
Hip/leg fracture*	699 (38.3)	17 (23.3)
Severe head injury**	414 (22.7)	7 (9.6)
Head/neck fracture	232 (12.7)	10 (13.7)
Mild head injury**	223 (12.2)	2 (2.7)
Shoulder/arm fracture	146 (8.0)	4 (5.5)
Injury to internal organ***	89 (4.9)	11 (15.1)

* $p \leq .01$. ** $p \leq .05$. *** $p \leq .001$.

in back-over collisions more likely to be admitted to hospital ($\chi^2 = 8.494$; $p = .037$). Forty-nine (33.1%) of the back-over collisions involved a vehicle backing out of a driveway; 21 (14.2%) occurred in roadways, 19 (12.8%) occurred in parking lots, and 59 (40%) of the locations were unspecified. The highest proportion of children involved specifically in driveway back-over collisions were in the 1–4 age group (69%), followed by children ages 5–9 (20%). There was a significant difference in the age distribution between back-over collisions occurring in driveways versus other locations, with significantly younger children involved in driveway collisions ($\chi^2 = 9.743$; $p = .021$).

Table II shows the most common injuries in children admitted to the hospital by collision type and distribution. Children in forward-moving/other collisions were more likely to sustain hip/leg fractures ($\chi^2 = 7.029$; $p = .008$) or severe ($\chi^2 = 3.862$; $p = .049$) or mild head injuries ($\chi^2 = 4.565$; $p = .033$). Children injured in back-over collisions were more likely to sustain injuries to internal organs compared to those injured in forward-moving/other collisions ($\chi^2 = 13.50$, $p = 0.0001$).

DISCUSSION

The current study found that children struck by reverse-moving vehicles had a different age and injury profile compared with those struck by forward-moving vehicles. In particular, back-over collisions involving younger children were more likely to result in internal organ and trunk injuries and were more likely to be admitted to hospital. Previous studies on back-over collisions focused primarily on driveway collisions and many reported the majority of victims' ages as 5 years old and younger (Fenton et al. 2005; Patrick et al. 1998; Silen et al. 1999). This finding was found to be consistent with our results when the analysis was restricted to collisions occurring on driveways. Children involved in back-over collisions that occurred in locations other than driveways were found to be older. When considering all children struck by reversing vehicles in our full sample, almost 50 percent were aged 5 or older and 16 percent were aged 10 or older.

The more inclusive definition of back-over collisions used in this study, as compared to research in other published literature, may also explain the differences in injury type for those admitted to hospital. Patrick et al. (1998) found that children involved in

driveway-related back-over collisions presented with a higher incidence of head and neck injuries compared to children involved in other types of pedestrian collisions. In contrast, our study found a significantly higher proportion of children with head injuries in the forward-moving/other collisions. As the prevalence of head injury in children admitted to hospital due to back-over injuries has been found to decrease with age, it is not surprising that our back-over population, which included a greater proportion of older children, would have fewer head injuries (Centers for Disease Control and Prevention 2005; Silen et al. 1999). A smaller number of head injuries in older children may presumably be due to differences in height, with their larger stature resulting in a decreased probability of the children's heads coming into contact with the car bumper in a back-over collision. This would also account for the finding of a higher proportion of internal organ and trunk injuries in the back-over collisions in this sample.

Vehicle type plays a considerable role in the phenomenon of back-over collisions, because larger vehicles, such as family vans and light trucks, are involved in a substantial proportion of back-over collisions (Agran et al. 1994; Fenton et al. 2005; Nadler et al. 2001; NHTSA 2006; Pinkney et al. 2006). Of important note, *Consumer Reports'* analyses of blind spots for the average height driver (5 feet 8 inches) demonstrated that large SUVs have an average blind spot of 14 feet compared to the smaller mid-sized sedan with an average blind spot of 5 feet (*Consumer Reports*, 2008). The growth and popularity of larger family vehicles have made back-over collisions a growing problem that must be addressed.

There are a number of possible limitations to our study that should be considered when interpreting the study results. Back-over collisions were classified by written narratives found in CHIRPP reports, and inadequate narratives could have resulted in misclassification of back-over collisions. In addition, there could be selection bias in the sample because parents involved in back-over incidents may have felt a sense of guilt; hence, less detail in the written narrative may have been provided. Information regarding vehicle type, driver characteristics, and details regarding how the back-over occurred were not consistently available, so further classification of data was not possible. Fatal injuries are also underestimated in CHIRPP because the only fatalities included in the database are those who were dead on arrival to hospital and those who died in the emergency department. Those who were pronounced dead at the scene and those who died after hospital admission were not included in the fatality count (Public Health Agency of Canada 2007). Further analyses on back-over collisions by vehicle type could not be completed due to the lack of available data in the CHIRPP data.

Many potential strategies exist which may prevent future back-over collisions in child pedestrians. In the past, it was found that physical separation of children from driveways has led to a decrease in the risk of driveway events; however, only 33.1 percent of back-over collisions in our sample occurred on the driveway (Roberts et al. 1995). Therefore, prevention strategies should take into account other environments where back-over

collisions may occur. Vehicular-based modifications, such as back-up sensors and cameras are also becoming more common despite the lack of evidence regarding their effectiveness. A report by National Highway Traffic Safety Association (NHTSA) in November 2006 emphasized that even with these cameras, there can still be blind spots at the corner of the vehicle and camera performance may vary by vehicle. NHTSA's research on nine vehicles with electronic sensor-based systems found that the detection of objects was not consistent, and children were not well detected (Mazzae 2007). Furthermore, cameras and back-over sensors may not be an effective overall strategy, because almost 50 percent of children involved in back-over collisions in our study were over the age of 5 years. These children would have been seen with standard rearview and side mirrors, even from a large vehicle.

Despite a greater amount of knowledge and increased awareness of back-over collisions, these preventable tragedies will continue to persist until the appropriate countermeasures are put into place. An important finding of this study was that only 33 percent of the back-over collisions in this sample occurred when a vehicle was backing out of a driveway. This highlights the importance of recognizing that not only do back-over collisions affect older children, but they also occur in a range of environments. New and innovative ideas are therefore required to address the wider scope of this problem. The challenge will be to develop appropriate prevention strategies to effectively address this growing public health concern.

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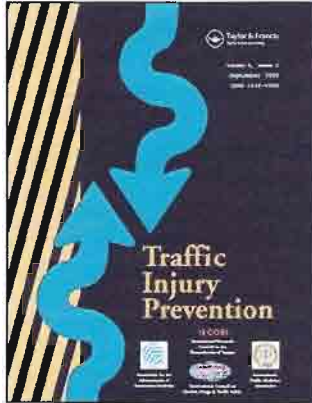
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