Pedestrian crossing location influences injury severity in urban areas

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ABSTRACT

Background Pedestrian incidents represent an increasing proportion of serious injuries resulting from motor vehicle collisions in Canada. However, few studies have examined the effect of pedestrian crossing location in urban areas on injury severity. The objective of this study was to investigate the relationship between pedestrian—motor vehicle collision injury severity and crossing location.

Methods This study was a population-based analysis of police-reported pedestrian collision data. The study group was pedestrian collisions from 1 January 2000 to 31 December 2009 in Toronto. Main outcome measures were a binary indicator of severe injury, and a four-level categorical variable of injury severity. The exposure variable was crossing at mid-block with no traffic control compared to signalised intersection. Analysis was via binary and multinomial logistic regression models to estimate ORs of injury severity with 95% CIs.

Results The analysis included 9575 pedestrian—motor vehicle collisions, of which 7325 occurred at signalised intersections when crossing and 2230 occurred at uncontrolled mid-block locations when crossing without right of way. Uncontrolled mid-block collisions resulted in greater injury severity when controlling for road type. The odds of severe injury were 1.75 (95% CI 1.07 to 2.86) for children, 2.55 (95% CI 2.13 to 3.05) for adults and 1.68 (95% CI 1.23 to 2.28) for older adults. The odds of death at uncontrolled mid-block crossings were 4.97 (95% CI 3.11 to 7.94) in adults and 3.49 (95% CI 2.07 to 5.89) in older adults.

Conclusions Crossing at uncontrolled mid-block locations resulted in greater injury severity compared with crossing at signalised intersections. This has important implications for pedestrian behaviour and traffic environment design and emphasises the need for safe pedestrian crossings on urban roads.

INTRODUCTION

There has been a decline in road traffic crashes in Canada over the last 10 years. Collisions involving pedestrians, however, have represented increasing proportions of serious injuries, up from 9.8% in 2003 to 12.5% in 2009.[1 2] Pedestrians account for 14% of all injury hospitalisations and 26% of deaths related to motor vehicle collisions.[3] The city of Toronto had the highest pedestrian collision rate among Canadian cities in 2009 at 78 per 100 000 population.[4]

Urban traffic environments are particularly dangerous for pedestrians. In Canada, from 2004 to 2006, 75% of pedestrian traffic fatalities occurred on city roads.[5] The majority of urban pedestrian collisions occur, as would be expected, at intersections, because of increased exposure of pedestrians to vehicles.[6] What remains unclear is whether pedestrian collision injury severity is different for those collisions occurring mid-block, compared with those at intersections.

Previous research regarding mid-block and intersection collisions and injury severity is inconsistent. Pitt *et al*[7] found in urban pedestrians under 20 years of age, injury severity was unaffected by whether the children were struck when crossing at mid-block versus at an intersection. Agran *et al*[8] found that the greatest proportion of children in a large urban centre were injured mid-block sustaining somewhat more severe Injury Severity Scores than those struck at intersections, but the differences were not significant. Conversely, in Florida, the odds of death at mid-block were 50% higher than at intersections and the mid-block death proportion was increasing.[9] Eluru *et al*[10] found similar results with reduced severe injuries and fatalities at signalised intersections compared to other crossing locations in the USA.

Injury severity is influenced by a variety of factors. For example, injury severity differs by age due to vulnerability to injury particularly in children and older people.[11–17] Age also influences the location of collisions, as younger children are more likely to be struck at mid-block and are more severely injured on lower speed neighbourhood roads than adults.[17 18] It is well established that higher vehicle speed and increased average traffic volume increase the risk of severe injury and death.[7 10 13 19–25] Road type may also influence where an individual chooses to cross the street and determines the exposure to vehicular traffic. Local and collector roads tend to be narrower than arterials resulting in a shorter crossing time. Drivers are also more likely to anticipate a pedestrian crossing lower speed road local or collector roads than higher speed arterial roads (City of Toronto, personal communication, 14 October 2011). Other factors that affect injury severity include pedestrian action at the time of collision, vehicle type, time of day, light and weather at the time of the collision.[7 13 26–28]

Pedestrian collisions are an important issue in urban environments because of high densities of pedestrians and vehicles. Walking has many health benefits such as prevention of obesity and related chronic conditions, and can potentially reduce traffic congestion and improve air quality. A safe walking environment is essential to promote walking in cities. The purpose of this paper was to investigate the relationship between pedestrian injury severity and collision location, specifically when crossing the road, controlling for age, presence of a traffic control and road type. We hypothesised that crossing at a mid-block location with no traffic control would result in greater severity of injury compared to crossing at an intersection with traffic lights across all ages, when controlling for road type.

METHODS

A population-based analysis of police-reported motor vehicle collisions in the City of Toronto from 1 January 2000 to 31 December 2009 was conducted. As the analysis involved data hosted in the public domain, no Research Ethics Board approval was required as per hospital policy.

Data source

The data were extracted from Motor Vehicle Collision Reports filed by the Toronto Police Service and were obtained from the City of Toronto, Transportation Services Division. Collisions where the pedestrian crossed the road either at an intersection with a traffic light or without right of way at an uncontrolled mid-block location were included. Collisions that occurred when the pedestrian darted into the roadway without intent to cross, was walking along the roadway, was getting in/out of vehicle or that occurred on private property were excluded.

Outcome variables

The outcome variable was police reported injury severity from the motor vehicle collision reports. All traffic collisions that result in injury are investigated by Toronto police officers, who complete motor vehicle collision reports. Witness statements are screened when completing the report. The collision report is a standard report form designated by the Province of Ontario. Collisions that do not result in injury are self-reported to a collision centre (City of Toronto, personal communication, 30 November 2011) Injury was coded by police according to the Ontario Ministry of Transportation scheme as follows:[29] no injury; minimal injury: that is, scrapes and bruises but no hospital visit; minor injury: hospital visit, was treated in the emergency room but not admitted; major injury: requiring hospital admission; and fatal: died within 30 days as a result of the collision.

Two outcome variables based on injury severity were constructed. In the primary analysis a dichotomous variable was used that compared 'severe' injury (defined as major or fatal injury) with 'minor' injury (defined as no injury, minimal or minor injury). In the secondary analysis, the outcome variable consisted of four levels of injury severity: no injury, minor injury (defined as minimal or minor), major injury and fatal injury. Minor and minimal injury were combined into one category due to small numbers, and the likelihood that differentiating between the two at the scene of the collisions would be problematic.

Exposure

The exposure variable indicated the pedestrian action and crossing location at the time of the collision; mid-block crossing with no traffic control and without right of way (henceforth referred to as uncontrolled mid-block crossing), versus intersection crossing with a traffic light (referred to as a signalised intersection). Three fields from the police dataset were used to create this variable: (1) location of the collision, which indicated whether it had occurred at an intersection, mid-block, or other location; (2) traffic control, which indicated the presence and type of traffic control; and (3) pedestrian action, which indicated whether the individual was crossing at the time and whether they had the right of way.

Covariates

Independent variables were selected based on theoretical importance in previous studies, availability and completeness of data and significance in the bivariate analysis with a p value <0.05. Other variables included in the dataset that were considered but did not meet criteria were road surface condition, light conditions and visibility.

Road type was included as a categorical covariate. Local and collector roads, which typically have lower posted and operating speeds and lower volumes when compared to arterial roads, were used as the baseline category. These roads were coded together as they have similar posted speed limits (40–50 km/h) and were relatively small categories. Major and minor arterial roadways were coded as individual categories. Major arterial roadways have a speed limit of 50–60 km/h, with a daily traffic volume of >20 000 vehicles. Minor arterials have a speed limit of 40–60 km/h, with a daily traffic volume of 8000–20 000 vehicles. The 'other' category included ramps, expressways and laneways.[30]

The age variable was created according to three groups: <18 (children), 18–64 (adults) and 65+ (older adults). The primary and secondary analyses were also conducted with the child age group broken down into four categories: 0–4, 5–9, 10–14 and 15–17 years. Results using multiple paediatric age groups were unstable given small numbers in each category and were therefore, not reported.

Statistical analysis

Statistical analysis was conducted using SAS software.[31] Binary logistic regression modelling was conducted for the model with the binary severity outcome with crossing location entered as the exposure variable. Road type was included as the only covariate meeting inclusion criteria. A multinomial logistic regression model was created for the injury severity outcome coded with multiple levels, again with crossing location entered as the exposure variable and road type as the covariate. Both models were stratified by age. The χ^2 p values were used to examine the association between the exposure and the outcome by age category. Significance was determined at the $p<0.05$ level.

ORs and 95% CIs were calculated to examine age-specific relationships between injury severity and uncontrolled mid-block collisions versus signalised intersection, adjusted for road type.

RESULTS

A total of 23 428 collisions involving pedestrians were reported to the police in the City of Toronto from 2000 to 2009. There were 9575 collisions, which occurred either at a signalised intersection when crossing, or at an uncontrolled mid-block location when crossing without right of way. The age-stratified analysis included 9363 collisions as there were 212 cases missing age information. Table 1 describes pedestrian collision severity by crossing location and age.

The majority (77%) of reported collisions occurred while crossing at a signalised intersection. Crossing at uncontrolled mid-block locations represented 24% of all collisions resulting in injury and 49% of all fatal pedestrian collisions. The greatest number of collisions occurred in adults (6707, 72%) followed by children (1394, 15%) and older adults (1262, 14%). Approximately 10% of collisions resulted in a severe or fatal injury, with

Table 1 Collision severity by crossing location stratified by age (n=9363)*

	Total (%)	No injury	Minor injury	Major injury	Fatal injury	Severe injury (major + fatal)	p Value
All							
Signalised intersection	7345 (77)	3062 (42)	3640 (50)	560 (8)	83 (1)	643 (9)	<0.0001
Uncontrolled mid-block	2230 (23)	804 (36)	1073 (48)	274 (12)	79 (4)	353 (16)	
Total	9575	3866 (40)	4713 (49)	834 (9)	162 (2)	996 (11)	
Children (<18)							
Signalised intersection	1028 (74)	534 (52)	435 (42)	58 (6)	1 (0)	59 (6)	<0.0001
Uncontrolled mid-block	366 (26)	148 (40)	185 (51)	29 (8)	4 (1)	33 (9)	
Total	1394	682 (49)	620 (45)	87 (6)	5 (1)	92 (7)	
Adults (18–64)							
Signalised intersection	5240 (78)	2137 (41)	2705 (52)	360 (7)	38 (1)	398 (8)	<0.0001
Uncontrolled mid-block	1467 (22)	518 (35)	714 (49)	196 (13)	39 (3)	235 (16)	
Total	6707	2655 (40)	3419 (51)	556 (8)	77 (1)	633 (9)	
Older adults (65+)							
Signalised intersection	926 (73)	279 (30)	465 (50)	138 (15)	44 (5)	182 (20)	0.002
Uncontrolled mid-block	336 (26)	87 (26)	165 (49)	48 (14)	36 (11)	84 (25)	
Total	1262	366 (29)	630 (50)	186 (15)	80 (6)	266 (21)	

*Total number of cases missing ages=212.

a greater proportion of severe or fatal injuries at mid-block than at intersection (16% vs 9%). The highest proportion of severe and fatal collisions occurred in older adults (21% vs 9% adults, 7% children). In children, there were a total of five fatalities; four of which occurred at mid-block locations. In adults, the numbers of fatalities at both locations were similar with 38 occurring at intersections and 39 occurring at mid-block. In older adults, there were 1.2 times as many fatalities at signalised intersections than at uncontrolled mid-block locations.

The odds of severe injury were significantly higher in all age groups at uncontrolled mid-block locations compared to signalised intersections (table 2). The odds of severe injury (after adjusting for road type) were 1.75 (95% CI 1.07 to 2.86) for children, 2.55 (95% CI 2.13 to 3.05) for adults and 1.68 (95% CI 1.23 to 2.28) for older adults when crossing at uncontrolled mid-block locations. The odds of a severe injury were increased for adults (OR 2.07, 95% CI 1.33 to 3.22) and older adults (OR 4.18, 95% CI 1.57 to 11.13, OR 5.78, 95% CI 2.26 to 14.79) for higher speed roads, compared to local/collectors. The small number of collisions among older adults contributed to wide CIs. There were also increased odds of severe injury for collisions on ramps and expressways in adults (OR 4.20, 95% CI 1.95 to 9.05).

In the secondary analysis, the odds of minor, major and fatal injury were significantly increased for children and adults at uncontrolled mid-block locations compared to signalised intersections, after adjusting for road type. Greater detail is provided in table 3.

DISCUSSION

Substantially more collisions occurred when crossing at signalised intersections; however, crossing at uncontrolled mid-block locations resulted in greater odds of severe injury and death when controlling for road type, and across all age groups.

This study confirmed the association between mid-block location and increased pedestrian injury severity seen in other studies using police-reported data. Comparable proportions of mid-block collisions resulting in injury and fatalities were reported by Ciu and Nambisan.[32] Mid-block collisions accounted for 28% of collisions resulting in any injury (vs 24% in the present study), and 55% in those resulting in death (vs 49%). Even higher proportions were found in Florida, with 81% of fatal collisions occurring at mid-block from 1994 to 2001.[9] Eluru *et al*[10] also found that collisions at intersections resulted in less injury severity compared to crashes at other roadway locations including mid-block locations.

There are several possible reasons for discrepant results with other studies, which did not find an association between collision location and injury severity. Results would be affected by how collision location was operationalised. Stolloff highlighted

Table 2 Odds of severe injury (compared to not severe) when crossing at an uncontrolled mid-block location, compared to an intersection with a traffic light

	Severe injury	
	Unadjusted (95% CI)	Adjusted (95% CI)
Children (<18):		
Location		
Signalised intersection	1.00	1.00
Uncontrolled mid-block	1.64 (1.05 to 2.55)	1.75 (1 .07 to 2.86)
Road type		
Local/collectors	1.00	1.00
Minor arterial	0.88 (0.38 to 2.06)	1.28 (0.52 to 3.14)
Major arterial	0.87 (0.42 to 1.79)	1.30 (0.59 to 2.89)
Other	–	–
Adults (18–64):		
Location		
Signalised intersection	1.00	1.00
Uncontrolled mid-block	2.31 (1.94 to 2.74)	2.55 (2.13 to 3.05)
Road type		
Local/collectors	1.00	1.00
Minor arterial	0.95 (0.59 to 1.53)	1.62 (0.99 to 2.64)
Major arterial	1.13 (0.74 to 1.74)	2.07 (1.33 to 3.22)
Other	2.29 (1.08 to 4.84)	4.20 (1.95 to 9.05)
Older adults (65+):		
Location		
Signalised intersection	1.00	1.00
Uncontrolled mid-block	1.36 (1.01 to 1.83)	1.68 (1.23 to 2.28)
Road type		
Local/collectors	1.00	1.00
Minor arterial	3.17 (1.21 to 8.30)	4.18 (1.57 to 11.13)
Major arterial	4.21 (1.68 to 10.55)	5.78 (2.26 to 14.79)
Other	–	–

Table 3 Odds of minor, major and fatal injury (compared to no injury) when crossing at uncontrolled mid-block locations compared to signalised intersections

	Minor		Major		Fatal	
	Unadjusted (95% CI)	Adjusted (95% CI)	Unadjusted (95% CI)	Adjusted (95% CI)	Unadjusted (95% CI)	Adjusted (95% CI)
Children (<18):						
Crossing location						
Signalised intersection	1.00	1.00	1.00	1.00	1.00	1.00
Uncontrolled mid-block	1.52 (1.18 to 1.95)	1.60 (1.20 to 2.14)	1.80 (1.11 to 2.91)	1.99 (1.16 to 3.40)	14.42 (1.60 to 129.94)	16.06 (1.65 to 156.06)
Adults (18–64):						
Crossing location						
Signalised intersection	1.00	1.00	1.00	1.00	1.00	1.00
Uncontrolled mid-block	1.08 (0.95 to 1.23)	1.14 (1.00 to 1.31)	2.24 (1.84 to 2.73)	2.52 (2.05 to 3.10)	4.03 (2.53 to 6.39)	4.97 (3.11 to 7.94)
Older adults (65+):						
Crossing location						
Signalised intersection	1.00	1.00	1.00	1.00	1.00	1.00
Uncontrolled mid-block	1.14 (0.85 to 1.54)	1.26 (0.91 to 1.74)	1.12 (0.74 to 1.68)	1.46 (0.95 to 2.24)	2.62 (1.59 to 4.33)	3.49 (2.07 to 5.89)

discrepancies in the definitions of intersection-related collisions between States, ranging from a distance from an intersection from 50 ft to 500 ft.[33] In the study by Pitt *et al*, intersection collisions were defined if within 50 ft of an intersection (just over 15 m).[7] In the Toronto collision reports, intersection collisions are coded if occurring within 30 m of the intersection (City of Toronto, personal communication, 12 August 2011). Intersection collisions in the present study (with less severity) would be coded as mid-block in the study by Pitt *et al*, thus diluting the effect of increased severity of the mid-block location. Other studies investigating injury severity do not specify their definitions of mid-block and intersection collisions.[8] When comparing the results of different studies, it is essential that the definition of the location variable be comparable.

The discrepancy in results may also be related to the use of different severity outcomes. The present study and those by Eluru *et al* and Lee *et al* used police reported injury outcomes.[10 13] The two studies which found no association between severity and location used Injury Severity Scores codes.[7 8] Pedestrian collisions investigations using hospital and trauma registries have the benefit of increased accuracy of injury coding but are biased to include only the more severely injured. Police reported injury classification more closely matches hospital data the more serious the injury.[34–36] Combining the two least severe categories in our analyses minimises the limitations of police coding. The benefits of police reported data include detailed on-scene information regarding location and circumstances. Police collision data is also population-based and routinely collected which results in greater generalisability compared to data restricted to a particular hospital or trauma registry system. The ideal situation is to combine detailed on-site collision location information with accurate injury severity coding, such as was done by the US National Highway Traffic Safety Administration (NHTSA) in the Pedestrian Injury Causation Study from 1977 to 1980.[7] Such studies are however, extremely costly.

We verified collision location for every 100th collision by viewing the locations using ArcView and Google maps.[37] A total of 100% of intersection collisions were correctly classified, whereas 79% of mid-block locations were coded correctly. Misclassification was primarily due to collisions occurring within 30 m of an intersection with a crossing control, which would more accurately be coded as an intersection. As intersection collisions result in less severe injuries, the effect of this misclassification is that the ORs presented are conservative estimates.

Other limitations included the possibility of collision under-reporting, as it has been estimated that only 24% of motor vehicle collisions are reported to the police.[38] It is most likely that under-reporting occurs in collisions resulting in no or mild injury. There is no reason to believe there would be differential under-reporting at intersection versus mid-block locations. Another limitation was the low frequency of injury events when the paediatric age range was stratified, thus leading to unstable estimates.

Several factors that may affect injury severity were not included in the database. Although pedestrian fatalities differ by sex with higher death in males (61.3%), information regarding sex was not available.[39] Vehicle speed and traffic volume, which are important predictors of severity, were also unavailable. Vehicle speed may have been higher at mid-block locations where drivers were not expecting pedestrians crossing, which may have contributed to the increased severity of injury at mid-block. Road type was used as a surrogate for vehicle speed and traffic volume in this analysis. Although there is some overlap in the posted speed limits in the road type categories, the use of road classification appeared to be justified as higher odds of increased injury severity were evident with road classifications involving higher speed traffic and volumes.[40] However, higher odds of increased injury severity were not noted for children at higher speed roads in these analyses. This may be because vehicles on local roads may be travelling at speeds already high enough to result in serious injury for child pedestrians due to their short stature and risk of head injury.[17]

These analyses examined crossing location without qualifying the behaviour of the pedestrian. Mid-block crossing without right of way was examined, but these analyses did not differentiate between crossing with/without right of way at a signalised intersection. Again, the bias would be towards the null. Although work has been done using a combination of roadside observations and collision databases to generate relative risks for illegal crossing at signalised intersections versus mid-block, this has not included injury severity and would be an area for future study.[41] As signalised intersections can be considered the gold standard in terms of providing the safest environment for pedestrian crossing, future analyses should also compare injury severity at signalised mid-block crossings (ie, pedestrian cross-overs), with pedestrian collisions occurring at signalised intersections.

Many effectiveness studies of different types of signalised mid-block crossings have been reported, for example, Pedestrian user-friendly intelligent (Pelican) crossings and high-intensity

What is already known on the subject

- Higher traffic speed and volume affect pedestrian injury severity.
- Injury severity differs by age on major and neighbourhood roads.
- There is generally a higher frequency of intersection collisions than mid-block collisions.

What this study adds

- Data on increased injury severity and death at uncontrolled mid-block collisions compared to signalised intersections.
- Data on the highest odds of major injury and death at uncontrolled mid-block locations in adults ages 18–64.

activated crosswalks.[42–44] Effective treatments for uncontrolled mid-block locations are however, lacking. In a review of the literature, Sandt *et al* noted that many studies provide guidance on safety treatments to protect pedestrians, but few focus exclusively on mid-block crashes in general.[42] Wide arterial streets are a key issue; there is a significant increase in pedestrian crashes on multilane roads compared to two-lane roads.[45] There is a need to shorten pedestrian crossing distances in identified problem locations.[42] Roadways with raised median or crossing islands have significantly fewer pedestrian crashes.[45 46] Mid-block traffic signals, lane reductions, changes in lane widths and curb extensions may help.[42] Sandt *et al* also found that mean posted speed limit was higher at mid-block crash sites than at intersection collisions, and suggested traffic calming measures such as speed humps to reduce the occurrence and severity of mid-block collisions.[42]

Crossing at an uncontrolled mid-block location resulted in a greater likelihood of severe injury and death than crossing at signalised intersections. This has important implications for enforcement and for traffic environment design. Specific problem locations for mid-block collisions should be identified in the city of Toronto and appropriate intervention strategies designed. These results emphasise the need for a thorough understanding of the dangers of different crossing locations in order to achieve ideal solutions for safe pedestrian crossings in urban areas.

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REFERENCES

1. **Transport Canada.** *Canadian Motor Vehicle Traffic Collision Statistics: 2003, TP3322*. 2004. http://www.tc.gc.ca/eng/roadsafety/tp-tp3322-2003-menu-630.htm (accessed 24 Nov 2010).
2. **Transport Canada.** *Canadian Motor Vehicle Collision Statistics: 2009. TP3 322*. 2011. http://www.tc.gc.ca/eng/roadsafety/tp-tp3322-2009-1173.htm (accessed 11 Sep 2011).
3. **Canadian Institute for Health Informaton.** *National trauma registry 2011 report: hospitalizations for major injury in Canada, 2008-2009 Data*. 2011. http://secure.cihi.ca/cihiweb/products/NTR_CDS_2008_2009_Annual_Report.pdf (accessed 11 Sep 2010).
4. **City of Toronto, Transportation Services, traffic management centre, traffic safety Unit.** *Pedestrian Collision Summary Leaflet-December 2010*. 2009. http://www.toronto.ca/transportation/publications/brochures/2009_ped.pdf (accessed 11 Sep 2011).
5. **Transport Canada.** *A quick look at fatally injured vulnerable road users. Fact Sheet TP 2436E RS-2010-2*. 2010. http://www.tc.gc.ca/eng/roadsafety/tp-tp2436-rs201002-1067.htm (accessed 22 Nov 2010).
6. **Moudon AV,** Lin L, Jiao J, *et al*. The risk of pedestrian injury and fatality in collisions with motor vehicles, a social ecological study of state routes and city streets in King County, Washington. *Accid Anal Prev* 2011;**43**:11.
7. **Pitt R,** Guyer B, Hsieh C, *et al*. The severity of pedestrian injuries in children: an analysis of the pedestrian injury causation study. *Accid Anal Prev* 1990;**22**:549.
8. **Agran PF,** Winn DG, Anderson CL. Differences in child pedestrian injury events by location. *Pediatrics* 1994;**93**:284.
9. **Centre for Urban Transportation Research.** *Pedestrian Safety at Midblock*. 2006. http://www.dot.state.fl.us/research-center/Completed_Proj/Summary_PL/FDOT_BD544_16_rpt.pdf (accessed 22 Nov 2010).
10. **Eluru N,** Bhat CR, Hensher DA. A mixed generalized ordered response model for examining pedestrian and bicyclist injury severity level in traffic crashes. *Accid Anal Prev* 2008;**40**:1033–54.
11. **Oxley J,** Flides B, Ihsen E, *et al*. Differences in traffic judgments between young and older pedestrians. *Accid Anal Prev* 1997;**29**:839–47.
12. **Scialfa C,** Guzy L, Leibowitz H, *et al*. Age differences in estimating vehicle velocity. *Psychol Aging* 1991;**6**:60–6.
13. **Lee C,** Abdel-Aty M. Comprehensive analysis of vehicle-pedestrian crashes at intersections in Florida. *Accid Anal Prev* 2005;**37**:775–86.
14. **Demetriades D,** Murray J, Martin M, *et al*. Pedestrians injured by automobiles: relationship of age to injury type and severity 1. *J Am Coll Surg* 2004;**199**:382–7.
15. **Kim JK,** Ulfarsson GF, Shankar VN, *et al*. A note on modeling pedestrian-injury severity in motor-vehicle crashes with the mixed logit model. *Accid Anal Prev* 2010;**42**:1751–8.
16. **Martin ND,** Grabo DJ, Tang L, *et al*. Are roadside pedestrian injury patterns predictable in a densely populated, urban setting? *J Surg Res* 2010;**163**:323–6.
17. **Rothman L,** Slater M, Meaney C, *et al*. Motor vehicle and pedestrian collisions: burden of severe injury on major versus neighborhood roads. *Traffic Inj Prev* 2010;**11**:43–7.
18. **DiMaggio C,** Durkin M. Child pedestrian injury in an urban setting: descriptive epidemiology. *Medicine* 2002;**9**:54–62.
19. **Anderson RW,** McLean AJ, Farmer MJ, *et al*. Vehicle travel speeds and the incidence of fatal pedestrian crashes. *Accid Anal Prev* 1997;**29**:667–74.
20. **Garder PE.** The impact of speed and other variables on pedestrian safety in Maine. *Accid Anal Prev* 2004;**36**:533–42.
21. **Roberts I,** Norton R, Jackson R, *et al*. Effect of environmental factors on risk of injury of child pedestrians by motor vehicles: a case-control study. *BMJ* 1995;**310**:91.
22. **Mayr JM,** Eder C, Berghold A, *et al*. Causes and consequences of pedestrian injuries in children. *Eur J Pediatr* 2003;**162**:184–90.
23. **Sze NN,** Wong SC. Diagnostic analysis of the logistic model for pedestrian injury severity in traffic crashes. *Accid Analy Prev* 2007;**39**:1267–78.
24. **Transport Research Centre.** *Speed Management Report*. 2006. http://www.internationaltransportforum.org/Pub/pdf/06Speed.pdf (accessed 14 Sep 2010).
25. **World Health Organization.** *Global Status Report on Road Safety: Time for Action*. 2009. http://whqlibdoc.who.int/publications/2009/9789241563840_eng.pdf (accessed 14 Sep 2010).
26. **Henary BY,** Crandall J, Bhalla K, *et al*. Child and adult pedestrian impact: the influence of vehicle type on injury severity. *Annu Proc Assoc Adv Automot Med* 2003;**47**:105–26.
27. **Roudsari BS,** Mock CN, Kaufman R, *et al*. Pedestrian crashes: higher injury severity and mortality rate for light truck vehicles compared with passenger vehicles. *Inj Prev* 2004;**10**:154–8.
28. **Siddiqui NA,** Chu X, Guttenplan M. Crossing locations, light conditions and pedestrian injury severity. *Trans Res Rec* 2006;**1982**:141.
29. **City of Toronto.** *Toronto Bicycle/Motor Vehicle Collision Study*. 2003. http://www.toronto.ca/transportation/publications/bicycle_motor-vehicle/index.htm (accessed 23 Sep 2010).
30. **City of Toronto.** *Road Classification System*. 2008. http://www.toronto.ca/transportation/road_class/pdf/rc_document.pdf (accessed 23 Sep 2010).
31. **SAS Institute Inc.** *Base SAS 9.2: Procedures Guide: Statistical Procedures*. Cary, NC: SAS Institute Inc., 2008.
32. **Cui Z,** Nambisan SS. Methodology for evaluating the safety of midblock pedestrian crossings. *Trans Res Rec* 2003;**1828**:75–82.

33. **Stolloff ER.** Intersection and junction fatalities in the context of access management. *Proceedings for 2008 National Conference on Access Management*. 16—18 July 2008. Baltimore, MD, USA: Transportation Research Board (TRB); 2008.
34. **Sciortino S,** Vassar M, Radetsky M, *et al*. San Francisco pedestrian injury surveillance: mapping, under-reporting, and injury severity in police and hospital records. *Accid Analy Prev* 2005;**37**:1102—13.
35. **McDonald G,** Davie G, Langley J. Validity of police-reported information on injury severity for those hospitalized from motor vehicle traffic crashes. *Traffic Inj Prev* 2009;**10**:184—90.
36. **Lopez DG,** Rosman DL, Jelinek GA, *et al*. Complementing police road-crash records with trauma registry data—an initial evaluation. *Accid Anal Prev* 2000;**32**:771—7.
37. **ESRI.** *ArcGIS Desktop: Release 10.0*. Redlands, CA, USA: Environmental Systems Research Institute (ESRI), 2010.
38. **Harris S.** The real number of road traffic accident casualties in The Netherlands: a year-long survey. *Accid Anal Prev* 1990;**22**:371—8.
39. **Transport Canada.** *Trends in Motor Vehicle Traffic Collision Statistics 1986-1997, TP13743E*. 2001. http://www.tc.gc.ca/eng/roadsafety/tp-tp13743-2000-menu-162.htm (accessed 22 Sep 2010).
40. **City of Toronto, Transportation Services Division.** *Pedestrian Collision Study*. 2007. http://www.toronto.ca/transportation/walking/pdf/ped_collision_study-full_report.pdf (accessed 7 Dec 2010).
41. **King MJ,** Soole D, Ghafourian A. Illegal pedestrian crossing at signalised intersections: incidence and relative risk. *Accid Anal Prev* 2009;**41**:485—90.
42. **Sandt L,** Zegeer CV. Characteristics related to midblock pedestrian—vehicle crashes and potential treatments. *Trans Res Rec* 2006;**1982**:113—21.
43. **Glock JW,** Nassi RB, Hunt RE, *et al*. *Implementation of a Program to Reduce Pedestrian Related Accidents and Facilitate Pedestrian Crossings*. Tuscon, Arizona: City of Tucson Transportation Department, 2000.
44. **Lalani N.** *Are pelican crossings safe? Greater London Intelligence Quarterly, Report No. 33*. London UK, 1975.
45. **Zegeer C,** Stewart J, Huang H, *et al*. *Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations-Executive Summary and Recommended Guidelines*. McLean, VA, USA: FHWA; 2002.
46. **Bowman BL,** Vecelli RL. Effect of urban and suburban median types on both vehicular and pedestrian safety. *Trans Res Rec* 1994:169.

Grandads and gun violence

A grandfather in Texas ‘accidentally’ shot his 3-year-old granddaughter when he was aiming at a stray cat. Another report describes a grandfather who shot his 10-year-old grandson outside of a hunting store while unloading an antique rifle. Yet another story relates to a grandson who was ‘accidentally’ shot while target shooting with pistols. Among the 72 comments, many questioned whether this was truly ‘accidental’. One wrote: ‘Sad story. Pistols do not accidentally shoot people.

1. The pistol was loaded
2. The shooter had their finger on the trigger
3. The pistol was aimed at something not intended as a target safe ‘gun handling’. The writer added that these are all violations of safe gun handling.

Kill disobedient children

A US Republican congressional candidate wrote a book in which he argued that ‘The maintenance of civil order in society rests on the foundation of family discipline. Therefore, a child who disrespects his parents must be permanently removed from society in a way that gives an example to all other children of the importance of respect for parents. The death penalty for rebellious children is not something to be taken lightly. The guidelines for administering the death penalty to rebellious children are given in Deut 21:18–21’. He adds, ‘This passage does not give parents blanket authority to kill their children. The threat of death would, however, ‘be a tremendous incentive for children to give proper respect to their parents’.

Speed cameras more acceptable in UK

A recent UK survey found that people think speed cameras are more acceptable now than they did 5 years ago. In 2007, 30% of respondents said speed cameras were not acceptable; in 2012 that figure fell to 16%. The results indicate that 85% believe speed cameras have contributed to the fall in road deaths since the 1990s. An interesting side story is that these cameras are least popular in Wales, which has the highest rate of speeders! By contrast, cameras are most popular in Scotland, where only 14% were caught speeding.

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Pedestrian crossing location influences injury severity in urban areas

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