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Urban crash-related child pedestrian injury incidence and characteristics associated with injury severity

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ABSTRACT

Objective: Describe age-based urban pedestrian versus auto crash characteristics and identify crash characteristics associated with injury severity.
Materials and methods: Secondary analysis of the 2004–2010 National Highway and Traffic Safety Administration database for Illinois. All persons in Chicago crashes with age data who were listed as pedestrians ($n = 7175$ child age ≤ 19 yo, $n = 16{,}398$ adult age ≥ 20 yo) were included. Incidence and crash characteristics were analyzed by age groups and year. Main outcome measures were incidence, crash setting, and injury severity. Multivariate logistic regression analysis was performed to estimate injury severity by crash characteristics.
Results: Overall incidence was higher for child (146.6 per 100,000) versus adult (117.3 per 100,000) pedestrians but case fatality rate was lower (0.7% for children, 1.7% for adults). Child but not adult pedestrian injury incidence declined over time (trend test $p < 0.0001$ for <5 yo, 5–9 yo, and 10–14 yo; $p < 0.05$ for 15–19 yo, $p = 0.96$ for ≥ 20 yo). Most crashes for both children and adults took place during optimal driving conditions. Injuries were more frequent during warmer months for younger age groups compared to older (χ^2 $p < 0.001$). Midblock crashes increased as age decreased ($p < 0.0001$ for trend). Most crashes occurred at sites with sub-optimal traffic controls but varied by age ($p < 0.0001$ for trend). Crashes were more likely to be during daylight on dry roads in clear weather conditions for younger age groups compared to older (χ^2 $p < 0.001$). Daylight was associated with less severe injury (child OR 0.93, 95% CI 0.87–0.98; adult OR 0.90, 95% CI 0.87–0.93).
Conclusion: The incidence of urban pedestrian crashes declined over time for child subgroups but not for adults. The setting of pedestrian crashes in Chicago today varies by age but is similar to that seen in other urban locales previously. Injuries for all age groups tend to be less severe during daylight conditions. Age-based prevention efforts may prove beneficial.

1. Introduction

1.1. Current pedestrian crash injury knowledge

Each year in the United States (US), approximately 900 child pedestrians (<19 years old (yo)) are killed with an additional 51,000 injured and 5300 hospitalized secondary to injuries (Committee on Injury, Violence, and Poison Prevention, 2009). This accounts for 45,000 days of hospitalizations and >$290 million in inpatient charges (Conner et al., 2010). Children follow a unique developmental pattern prior to reaching adulthood which puts them at risk for different pedestrian behaviors and crash characteristics. For example, a toddler may not realize the consequences of dashing between parked cars into the road to follow a runaway ball whereas an adult may have the ability to follow pedestrian signals but choose not to for one reason or another. The resulting crash characteristics likely vary. Studies suggest that pedestrian injuries follow age-based trends that also vary by gender, location, environmental, and social factors. An

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analysis of New York data suggested the incidence of child pedestrian injuries to be 246 per 100,000 with a case fatality rate of 0.6% but that these crashes are becoming less frequent. Further, the analysis found younger children were more likely to be hit midblock during daylight and an increase during summer months but that road and weather conditions had no significant affect (DiMaggio and Durkin, 2002). Other studies suggest increased injury rates in males, less fatal injury in children, increased severity in mid-block crashes, and that about 18% of all pedestrian crashes are hit-and-run (Centers for Disease Control and Prevention Morbidity and Mortality Weekly Report, 2013; Stimpson et al., 2013; Slaughter et al., 2014; MacLeod et al., 2012; Rothman et al., 2012). However, as suggested by Ulfarsson et al., there is much variability in the literature making it unclear if these findings are generalizable to other geographic locations for use in targeted injury prevention initiatives (Ulfarsson et al., 2010).

1.2. Influence of traffic technology changes, personal electronic device use, and regulations

Large strides have been made in traffic technologies such as countdown signals, road design, and in-vehicle technology (e.g. rear cameras, backup sensors, pedestrian detection systems, blind spot information systems, predictive forward collision warning systems). These have likely decreased child pedestrian versus auto events. While data are conflicting about the utility of pedestrian countdown signals as an injury prevention strategy, in 2006 Chicago regulated that all new pedestrian signals and all those needing repair be done with countdown signals (Camden et al., 2012; Markowitz et al., 2006; Federal Highway Administration, 2008; Richmond et al., 2013).

Personal electronic device utilization is also likely modifying both driver and pedestrian behaviors. Cellphone use is steadily increasing with approximately 88% of adults and 77% of children 12–17 yo owning cellphones in 2011 (up from 75% in 2009 and 45% in 2004) (Lenhart, 2012; Smith, 2012). Studies suggest that child pedestrian safety is compromised when children use cellphones or headphones; similar findings have been shown in college age and adult pedestrians (Stavrinos et al., 2009, 2011; Chaddock et al., 2012; Schwebel et al., 2012; Nasar et al., 2008; Lichenstein et al., 2012). Increases in adult cellphone use over time have led to more distractions for drivers as well with 5% of drivers using hand held devices while driving in 2010 (Thompson et al., 2012; Young et al., 2012; Neyens and Boyle, 2007; Smith, 2010; National Highway Traffic Safety Administration, 2012). The data show that both hand held and hands free cellphone use while driving negatively impact driver performance (Ishigami and Klein, 2009; Klauer et al., 2013; Caird et al., 2008; Wilson and Stimpson, 2010). Furthermore, studies show that while pedestrian crash incidence is declining, pedestrian deaths from distracted driving are on the rise (Stimpson et al., 2013).

Several laws were implemented in Chicago and state-wide to minimize distracted driving risks to pedestrians (see Appendix A online for timeline of interventions). The most notable of these regulations included the 2005 Chicago ban on handheld cellphone devices while driving, the 2008 Chicago texting while driving ban, and the 2010 Illinois state-wide texting while driving ban.[1,2,3] However, studies have shown varying efficacy of similar policies in other locals (McCartt et al., 2014; Lim and Chi, 2013).

1.3. Goals and hypothesis

Our study is designed to provide an age-based description of current pedestrian injury incidence, trends, and crash characteristics of urban child (≤19 yo) and adult (≥20 yo) pedestrian versus auto events in the setting of these multifactorial changes. The aim is to better understand current age-based trends in urban child pedestrian injury characteristics compared to their adult counterparts in order to inform prevention and education practices. We hypothesize that traffic technology changes, personal electronic device use, and regulations are altering pedestrian crash incidence, trends, and characteristics.

2. Materials and methods

2.1. Data sources and inclusion criteria

A descriptive, population based study was conducted on child (≤19 yo) and adult pedestrian crashes in Chicago from 2004 to 2010. These years were chosen to coincide with Chicago injury prevention initiatives and to include the most recent data available. Data were obtained from National Highway and Traffic Safety Administration (NHTSA) statewide data extract files. These data are based on the Illinois Traffic Crash Report SR 1050 (ITCR) forms, are maintained by NHTSA, and are in the public domain. The ITCR form is completed by a law enforcement officer for each reported crash and is the only crash report form approved by Illinois law. The NHTSA database, rather than the Fatality Analysis Reporting System (FARS) or the National Vital Statistics System, was selected because it provides the most inclusive pedestrian injury data and is less likely to underestimate the true number of injuries since all reported crashes regardless of severity are included.

Data are provided from NHTSA as anonymous data in three separate files for each year – a crash file, a person file, and a vehicle file. All information was coded by NHTSA. The original database for the state of Illinois from 2004 to 2010 included 2,676,621 crashes and 6,246,277 people; 41,640 pedestrians were involved in crashes. A case was considered to be any child (≤19 yo) or adult (≥20 yo) pedestrian involved in a crash that took place in Chicago for which a crash report was completed and pedestrian age provided. See Appendix B for age breakdown of included cases. There were 1549 of 25,122 cases (6%) that were excluded due to lack of age data. When compared to cases where age was known, cases where age was unknown had less severe injuries (0.1% versus 1.4% fatal, $p < 0.001$), more males (57% versus 53%, $p < 0.05$), increased midblock crashes (57% versus 49%, $p < 0.001$), more crashes at uncontrolled sites (59% versus 53%, $p < 0.001$), and fewer hit-and-run crashes (26.3% versus 33.5%, $p < 0.001$) but no differences in light, road, weather, or month category. Some crashes involved more than one pedestrian in which case all pedestrians with age data were included in the analysis as individual cases.

For driver analysis, drivers in pedestrian crashes involving more than one driver were excluded from analysis ($n = 913$ cases total, 317 in child pedestrian crashes, 596 in adult pedestrian crashes). For each crash involving a single driver hitting multiple pedestrians, the driver was only included once for each crash involving child pedestrians and once for each crash involving adult pedestrians (see Appendix C).

Population data were obtained using the US Census (2010). Analysis was conducted based on the following age categories: <5 yo, 5–9 yo, 10–14 yo, 15–19 yo and ≥20 yo. These age groups were chosen based on conventional US Census age categories and those used in similar studies. Average yearly incidence for each age category was calculated by dividing the total number of crashes by 7 (the number of years included in the study) and further dividing

[1] Illinois Texting Laws. http://www.distracteddrivinghelp.com/illionis-texting-laws (accessed 24 Sept, 2012).

[2] Illinois Graduated Driver Licensing Program Parent-Teen Driving Guide. http://www.cyberdriveillinois.com/publications/pdf_publications/dsd_a217.pdf (accessed 4 Oct, 2012).

[3] Teen Driver Safety Task Force. http://www.cyberdriveillinois.com/departments/drivers/teen_driver_safety/gdltaskforce.html (accessed 4 Oct, 2012).