BRIEF REPORT

Differential ranking of causes of fatal versus non-fatal injuries among US children

M F Ballesteros, R A Schieber, J Gilchrist, P Holmgreen, J L Annest

Objective: Leading causes of fatal and non-fatal injury among US children aged <15 years were compared.

Method: A descriptive study was conducted using nationally representative data on injury related deaths (National Vital Statistics System) and on non-fatal injury related emergency department visits (IEDV; National Electronic Injury Surveillance System–All Injury Program). Data were accessed using a publicly available web based system.

RESULTS

The high number of deaths from injury among US children has been a major factor in prioritizing injury as a public health problem. While injuries are the leading cause of death among US children between 1 and 14 years of age, these deaths only represent a small fraction of those injured. Injury accounts for one third of all emergency department visits among children younger than 15 years, making injury the leading cause of emergency department visits in this age group. The distribution by cause of non-fatal injuries has not received the same consideration as that of fatalities when setting public health priorities for research and programs. Currently available fatal and non-fatal injury data from nationally representative surveillance systems can now enhance our ability to consider both. This study compared the leading causes of fatal and non-fatal injury among children in the US.

METHODS

Data were obtained from the Web based Injury Statistics and Query System (WISQARS), a Centers for Disease Control and Prevention (CDC) web based interactive platform recently enhanced to include non-fatal injuries (http://www.cdc.gov/ncipc/wisqars). WISQARS allows for querying by age, race/ethnicity, sex, state (fatal data only), year, injury cause, injury intent, and disposition at emergency department discharge (non-fatal data only). National mortality data from 1999 (the latest reporting year available) were based on the National Vital Statistics System of the National Center for Health Statistics, CDC. Annual non-fatal national estimates of hospital emergency department visits were based on the National Electronic Injury Surveillance System–All Injury Program (NEISS-AIP), which is a probability sample representative of US emergency departments for the first 12 months of available data, July 2000 through June 2001. NEISS-AIP is a collaborative effort between the National Center for Injury Prevention and Control, CDC and the US Consumer Product Safety Commission.

We reviewed data for children younger than 15 years of age to determine the leading causes of fatal and non-fatal injury, regardless of intent. For each cause, we assessed cause specific lethality by computing the ratio of non-fatal injuries (expressed as injury related emergency department visits; IEDV) to the number of deaths (non-fatal to fatal ratio, NF:F). Age specific mortality rates were calculated using 1999 US Census Bureau population estimates. Non-fatal injury rates were calculated using the average US Census Bureau population estimates for 2000 and 2001, since the non-fatal data spanned two calendar years. Coefficients of variations and 95% confidence intervals around national estimates of numbers and rates were calculated using a direct variance estimation procedure that accounts for sample weights and the stratified sample design.

CONCLUSIONS: The leading causes of pediatric fatal and non-fatal injuries differed substantially. This study indicates the need for consideration of common causes of non-fatal injury, especially falls.
than the second leading cause, struck by/against (1.8 million IEDVs); however, these two causes were substantially less lethal, with NF:F = 19 000:1 and 15 000:1, respectively. Overexertion accounted for 448 000 IEDVs, but was not associated with any deaths.

Transportation related injuries, which included injuries to motor vehicle traffic occupants, pedal cyclists (principally bicyclists), and pedestrians, were an important cause of pediatric injury morbidity and mortality. In this age group, non-fatal pedal cycle injuries resulted in about 25% more IEDV than motor vehicle occupant injuries. Pedestrian injuries were the most lethal transportation cause (NF:F = 67:1).

Injury mortality rates and IEDV rates varied by age and cause (tables 2 and 3). Motor vehicle traffic occupant mortality rates were highest for infants and 14 year olds. Infants younger than 1 year and, to a lesser degree, children older than 13 years had high suffocation fatality rates. Drowning and pedestrian mortality rates were highest for children between 1 and 2 years of age. IEDV rates for falls were highest among children between 1 and 2 years of age. Struck by/against IEDV rates were highest among children between 1 and 3 years old, and after 11 years of age, it was the leading cause of IEDV. In contrast, overexertion IEDV rates generally increased with age. Among transportation related causes, motor vehicle

<table>
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<tr>
<th>IEDV rank</th>
<th>Fatal rank</th>
<th>Injury cause</th>
<th>No of IEDV*</th>
<th>No of fatalities†</th>
<th>IEDV/1 death</th>
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<td>Fall</td>
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<td>1037</td>
<td>14</td>
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<td>Gunshot/firearm‡‡</td>
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<td>297</td>
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<td></td>
<td>7111780</td>
<td>7365</td>
<td>966</td>
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</table>

†Based on 1999 National Vital Statistics data.
‡In WISQARS fatal data are included with natural/environment.
§Includes all pedal cyclists (traffic, non-traffic, unspecified).
||Non-fatal include only motor vehicle (MV) traffic occupants (excludes non-traffic and unknowns), fatalities include MV traffic occupant and unspecified traffic fatalities, of which most were occupant related.15
††In WISQARS fatal data are included with suffocation.
‡‡Includes handgun, rifle, shotgun, BB gun, and airgun.

Table 2 Annual related fatality rates* per 100000 population by cause, ages 0–14, US, 1999

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>MV traffic occupant†</th>
<th>Inhalation/suffocation</th>
<th>Drowning</th>
<th>Pedestrians‡</th>
<th>Fire/burn</th>
<th>Firearms</th>
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<td>2.25</td>
<td>0.34§</td>
<td>1.39</td>
<td>0.21§</td>
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<td>2.37</td>
<td>5.96</td>
<td>2.50</td>
<td>2.34</td>
<td>0.29§</td>
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<td>1.12</td>
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<td>0.45§</td>
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<td>0.84</td>
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†Includes motor vehicle (MV) traffic occupants and unspecified traffic fatalities, of which most were occupant related.
‡Includes all pedestrians (traffic, non-traffic, unspecified).
§Rate is unstable because of a sample size of fewer than 20 deaths.
occupant IEDV rates increased with age, while the pedal cycle IEDV rate was highest in those between 9 and 12 years.

**DISCUSSION**

This study indicated that for every pediatric injury related death approximately 1000 injured children received emergency department treatment. Stated in other terms, about 0.1% of children died from their injuries. Rates of IEDV and injury related mortality varied by cause of injury and age.

This study found that the large number of injuries caused by falls, struck by/against, and overexertion accounted for more than 60% of all pediatric IEDC yet were rarely fatal. Fall injury rates were highest among infants who are vulnerable because of their limited coordination, exploratory nature, and potential home hazards, while struck by/against and overexertion injury rates were most pronounced in older children who tend to be more active and involved in sports.

Results from this analysis were comparable to those generated by other databases. While NEISS-AIP estimated that children younger than 15 years of age account for 7.1 million IEDC data from the 1999 National Hospital Ambulatory Medical Care Survey (NHAMCS) estimated this as 8.2 million, a 13% difference. The NHAMCS estimate would be expected to be higher because it includes repeat emergency department visits for the same injury incident and it includes cases where the reason for the visit was an injury as well as those with injury diagnoses, while the NEISS-AIP estimate includes only the initial emergency department visit for an injury incident and only those cases with injury diagnoses as determined by an attending physician. The other major surveillance systems available for comparing injuries and deaths relate to traffic crashes. The National Highway Traffic Safety Administration tallies traffic related fatalities using the Fatality Analysis Reporting System and estimates non-fatal traffic related injuries using the National Automotive Sampling System General Estimates System (GES). Compared with our results, the NFP ratios generated by these systems were similar for motor vehicle traffic occupants, but substantially different for pedal cyclists and pedestrians. These differences are attributable to discrepancies in non-fatal injury data. Fatality Analysis Reporting System results are similar to the vital statistics fatality data; however, the NEISS-AIP capture of non-fatal transportation injuries is more complete than GES. GES is based on police incident reports and includes only those crashes that occur in traffic and that are reported to the police. Compared with GES, NEISS-AIP records 7.1% more injured motor vehicle occupants, 60% more traffic related pedestrians injured, and over four times more traffic related pedal cyclists injured.

The fatal and non-fatal injury related databases used in our analysis provide timely data for the injury pyramid. These databases can be used to indicate the annual incidence of the top three levels of the injury pyramid, namely deaths, hospitalizations, and emergency department visits. These databases cannot be used to indicate the bottom level of the pyramid: total episodes of injuries (including those untreated). Hospitalization estimates can be determined from the emergency department disposition field; however, with the 12 months of data for this analysis, we did not address the issue of hospitalizations because the estimates can be unstable for less common injuries. A more detailed analyses of hospitalizations by external cause and intent of injury will be possible as more years of NEISS-AIP data become available.

This study has several limitations. First, the injuries included only those treated in hospital emergency departments; injuries that were treated in outpatient clinics or doctors' offices, or not medically treated were not included. Second, the NEISS-AIP provides only national estimates and does not allow for estimates by region, state, or local jurisdiction. Third, non-fatal causes were based on International Classification of Diseases (ICD)-9 codes, while fatal data were based on ICD-10 codes. ICD-10 is more detailed, with 3000 more categories for all causes of death, and some of the rules for coding and for selecting the underlying cause of death have been changed to favor case ascertainment of injury. ICD-10 mortality and morbidity data were compared for different time periods. However, given the magnitude of these findings, our results would not likely differ if the same year of data had been available for both fatal and non-fatal injuries.

**IMPLICATIONS FOR PREVENTION**

Public health policy has been largely influenced by mortality data. New nationally based interactive databases now permit public health professionals to fully consider the importance of non-fatal injuries in developing priorities.

While our study indicated that falls constitute a large proportion of non-fatal injuries among children, causal factors...
such as playgrounds, sports, falls from beds or furniture, stairs, or falls from heights could not be determined. Development of preventive measures to address falls will require a better understanding of these etiologic factors.

**Key points**

- Although less devastating than deaths, non-fatal injuries occurred much more frequently, and their leading causes differed. For every pediatric injury death, approximately 1000 injured children received emergency department treatment.
- Among children, the leading causes of fatal injuries differed from leading causes of non-fatal injuries, indicating the need to consider causes of non-fatal injuries when prioritizing public health research and programs.
- Falls accounted for over 2.4 million pediatric emergency department visits and struck by/against accounted for 1.8 million pediatric emergency department visits each year. Further study into the etiologic factors is warranted to identify areas amenable to preventive measures.

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**REFERENCES**


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