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Fall-related traumatic brain injury in children ages 0–4 years

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Abstract

Introduction: Falls are the leading cause of traumatic brain injury (TBI) for children in the 0–4 year age group. There is limited literature pertaining to fall-related TBIs in children age 4 and under and the circumstances surrounding these TBIs. This study provides a national estimate and describes actions and products associated with fall-related TBI in this age group.

Method: Data analyzed were from the 2001–2013 National Electronic Injury Surveillance System–All Injury Program (NEISS–AIP), a nationally representative sample of emergency departments (ED). Case narratives were coded for actions associated with the fall, and product codes were abstracted to determine fall location and product type. All estimates were weighted.

Results: An estimated 139,001 children younger than 5 years were treated annually in EDs for nonfatal, unintentional fall-related TBI injuries (total = 1,807,019 during 2001–2013). Overall, child actions (e.g., running) accounted for the greatest proportion of injuries and actions by others (e.g., carrying) was highest for children younger than 1 year. The majority of falls occurred in the home, and involved surfaces, fixtures, furniture, and baby products.

Conclusions: Fall-related TBI in young children represents a significant public health burden. The majority of children seen for TBI assessment in EDs were released to home. Prevention efforts that target parent supervision practices and the home environment are indicated.

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Practical applications: Professionals in contact with parents of young children can remind them to establish a safe home and be attentive to the environment when carrying young children to prevent falls.

Keywords

Traumatic brain injury; Falls; Pediatrics; Young children

1. Background

Falls are the leading cause of nonfatal emergency department (ED) visits among children aged birth to 14 years, accounting for 2.4 million visits annually, and the leading cause of traumatic brain injury (TBI) ED visits for children in the 0–4 year age group (Taylor, Bell, Breiding, & Xu, 2017; Wang, Zhao, Wheeler, Yang, & Xiang, 2013). There is limited literature describing the number and circumstances of fall-related TBI in children under 5 years old. The few TBI studies available that describe injury circumstances lack reporting by age, limiting what information can be extrapolated and used for prevention efforts. Understanding the burden in this age group is critical as a TBI sustained in the midst of early brain development can affect behavior and cognitive skills and is associated with worse outcomes than an injury sustained later in development (Anderson, Catroppa, Morse, Haritou, & Rosenfeld, 2005; Anderson, Jacobs, Spencer-Smith, et al., 2010; Centers for Disease Control and Prevention [CDC], 2018; Crowe et al., 2016; Crowe, Catroppa, Babl, Rosenfeld, & Anderson, 2012).

Previous research that examined falls in children provides some insights about younger children who sustain fall injuries and the circumstances of the fall event. One study estimated that about 73% of all pediatric fall-related injuries occur between ages 1 and 9 years, and only 8% of pediatric fall-related injuries happen in infants. However, infants are more likely to suffer more severe injuries (Unni, Locklair, Morrow, & Estrada, 2012). Further, compared to older children, children 4 years old and younger are more likely to sustain head injuries, be hospitalized, or die from falls (Flavin, Dostaler, Simpson, Brison, & Pickett, 2006; Pomerantz, Gittelman, Hornung, & Husseinzadeh, 2012). Studies examining injury circumstances and location in younger children, report almost twice as many children are hospitalized due to falls from furniture than from stairs, but those children who fell from stairs are more likely to sustain head injuries (Pomerantz et al., 2012). Previous reports on injuries in the youngest children indicate many injuries are related to nursery and infant products (e.g., cribs; Burrows et al., 2015) furniture (Gaw, Chounthirath, & Smoth, 2017); stairs (Agran et al., 2003; Ibrahim, Wood, Margulies, & Christian, 2011; Mack, Gilchrist, & Ballesteros, 2008) and surfaces (e.g., carpet, tile floor; Haney, Starling, Jeisler, & Okwara, 2010).

When examining large healthcare administrative datasets, most previous pediatric TBI studies extracted the International Classification of Diseases (ICD-9) external-cause-of-injury codes (e-codes). However, e-codes only describe the injury mechanism and lack descriptions of the circumstances surrounding the fall incident, such as the action leading to the fall. Existing studies also suggest a link between developmental stages and incidence of

falls. The few studies that examine fall-related TBI by age using e-codes report a higher incidence in children younger than 2 years compared to older children (Burrows et al., 2015; Love, Tepas 3rd, Wludyka, & Masnita-Isuan, 2009) and injury mechanisms related to the developmental stage of motor skill acquisition, especially around the time children become ambulatory (Burrows et al., 2015; Ibrahim et al., 2011; Love et al., 2009). Children younger than 1 year compared to older children were more likely to sustain a fall-related TBI as a result of falling from caregivers' arms or a fall from infant products (Burrows et al., 2015; Gaw et al., 2017). These children were also more likely to have more severe injuries (Crowe et al., 2016); sustain a skull fracture (Ibrahim et al., 2011); and require hospitalization (Ibrahim et al., 2011).

This study uses the National Electronic Injury Surveillance System–All Injury Program (NEISS-AIP), which produces a short description of the mechanism of injury based on information in the medical record, to provide the circumstances behind the injuries in this population. This paper extends work on this topic with detailed analyses of national-level data for children aged birth to 4 years regarding the circumstances and locations of fall-related TBI events.

2. Methods

2.1. Data source

Data were acquired from the 2001–2013 NEISS–AIP, which is a nationally representative stratified probability sample of 66 hospitals having at least 6 beds and providing 24-h emergency services in the United States. NEISS–AIP is a collaborative effort between the Centers for Disease Control and Prevention (CDC) and the U.S. Consumer Product Safety Commission (2000). Data are collected daily from each participating hospital resulting in approximately 500,000 nonfatal injury-related ED visits annually. NEISS-AIP defines a nonfatal injury as bodily harm resulting from exposure to an external force or substance (mechanical, thermal, electrical, chemical, or radiant) or submersion. NEISS-AIP has been described in more detail in previously published reports (Quinlan, Thompson, & Annest, 1999; Schroeder & Ault, 2001) and has been used to study TBI at the national level (Cheng et al., 2016; Coronado et al., 2015). Data elements include age, body part injured, cause, diagnosis, case disposition, gender, a brief narrative, location of injury event, and product involvement.

2.2. Data analysis

Cases were selected if the child was ≤ 4 years, the TBI was sustained between 2001 and 2013, the injury was listed as unintentional, and the primary cause was a fall. For this analysis, TBI was defined as a brain injury. A person was classified as having a TBI if the primary body region injured was the head, and the principal diagnosis was either concussion, internal organ injury, or fractured skull. NEISS-AIP includes several possible case dispositions (e.g., treated and released, transferred, hospitalized, left, unknown). As in previous reports, cases that were transferred to another medical facility were combined with those hospitalized for analysis since both dispositions indicated a need for a higher level of care.

Data for each case included a 140 character narrative summarized by a NEISS medical record abstractor. These narratives often, but not always, included a brief description of the injury and its cause. For this study, narratives were searched using SAS index functions and a pre-selected list of injury actions (e.g., jump, play) to determine the frequency of actions in the narratives. The terms “fall” or “fell” were used when the narrative only included those descriptors. Narratives were divided between those in which an action verb was identified in the narrative (“child was jumping on the bed and fell off”) and those when an action verb was not in the narrative (“child fell”) or the narrative did not describe a fall (e.g., “bed fell on infant”; that is a bed fell on the infant, indicating the infant did not fall). Based on the SAS results, cases were pooled for individual case review, and coded by trained coders.

Two trained coders independently reviewed all narratives with a particular focus on how the injury occurred based on actions done by another person or by the child. The two coders reached agreement on 85% of the narratives; a third coder reviewed and reconciled all discrepancies (15% remaining). Coders were instructed to code each narrative with a specific word describing the action that initiated the fall. Child actions were classified as child-initiated if the action word (i.e., climb, fall, jump, play, roll, run, slip, stand, step, or trip) suggested that an action by the child caused the fall; the majority of cases (76%) had no other action information available other than a mention of the fall (e.g., “child fell down stairs”), and those were classified as a child-initiated action. In contrast, actions by others indicated that another person initiated the action that caused the fall (i.e., carry, drop, place, push, or pull). The underlying action was coded to determine the cause of the fall. For example, a child jumping on the couch who lost their balance and fell, was coded as “jump” or if a child was getting in or out of something it was coded as “get.” A child who fell from their parent’s arms was coded as carry. When two or more actions were present, the coder reviewed both action words, but only coded the initial action. For example, if a caregiver dropped the child’s car seat, and the child fell out, that case was coded as “dropped.”

All estimates were based on weighted cases. Sample weights were calculated by the CPSC based on the probability of selection of each hospital and the annual number of ED visits over time. Analyses were conducted using SAS, version 9.4 (SAS Institute, Inc.), and Joinpoint, version 4.5.0.1 (Statistical Methodology and Applications Branch, Surveillance Research Program, National Cancer Institute, http://surveillance.cancer.gov/joinpoint/) software. Joinpoint regression analyses were used to test the significance of trends across the study period. Annual percent change (APC) estimates that were statistically significant at $p < .05$ are presented to indicate the magnitude and direction of significant trends. Confidence intervals (CIs) were calculated using a direct variance estimation procedure that accounted for the sample weights and complex sample design (Schroeder & Ault, 2001).

NEISS abstractors assign product codes from a listing of hundreds of products involved in injuries, listing up to two products in no particular order. Both product codes involved in fall-related TBI cases were included and examined by single year of age (Schroeder & Ault, 2001).

3. Results

3.1. Fall-related TBI by child characteristics

On average, between 2001 and 2013 an estimated 139,001 children age 0–4 years were treated annually in EDs in the United States for non-fatal, unintentional fall-related TBI (Table 1).

This number increased over time going from 103,432 cases in 2001 to 182,069 in 2013. TBI in this age group was primarily coded as a diagnosis indicating an internal injury to the head (87.7%). Most children were treated and released from the ED (93%) and while the percentage of children hospitalized or transferred was small (5%), it equated to more than 6906 children annually.

The majority of the injured children were aged 1 or younger (< 1 = 30.8%; 1 year = 28.9%), males (55.8%), and white non-Hispanic (47.5%). Overall, the majority of the fall-related TBI in this age group occurred at home (83.5%), compared to street/public locations (10.9%), related to sports equipment and sports/recreational activities (2.9%) or school (2.6%). Between 2001 and 2013, the rate of ED visits increased (Table 1; Fig. 1). For those children ≤ 1 year of age, the slope increased significantly over the study period (average percent change (APC) = 6.9 for < 1 and 5.9 for those 1 year of age). The rate of fall-related TBIs also increased significantly for children age 3–4 years, but the APC was smaller (3 year olds = 5.2; 4 year olds = 5.1). The change over time for children age 2 years showed an upward inflection in 2007 (APC = 15.7) and then a downward inflection in 2010 (APC = 3.4; Fig. 1), but the segments were not statistically different ($p < .05$), and the rate for two-year old children in 2013 was not significantly lower than the rate in 2010.

3.2. Fall-related TBI by action type

Actions by the child (87.5%) accounted for the majority of injuries, with only 12.5% caused by the actions of others (Table 2).

In the majority of cases, there was insufficient information to attribute a precipitating action to the child as the narrative simply indicated the child fell. The next most common actions by the child leading to a fall varied by age. Before age 1 year, the child rolling or climbing were the second and third leading actions resulting in a fall. At age 1 year, child tripping, running, or climbing represented the second through fourth largest numbers of actions contributing to the fall. At ages 2, 3 and 4 years, running, jumping, or tripping represented the largest number of actions after just “fall.”

Actions by others was highest for those ≤ 1 year of age (59.7%). Overall, being dropped was the largest contributor across all age groups, followed by being carried. Being pushed rose from fourth contributor to fall-related TBIs among children < 1 year to second for 3 and 4 year olds.

3.3. Fall-related TBI by products

Products involved in the fall incident were examined by age (Table 3).

All cases have at least one product involved (100%). Surfaces such as floors, stairs, and carpets were involved in the highest number of TBI-related falls across all ages. Furniture (e.g., beds) was ranked second for ages 1–4 years. Fall-related TBI involving baby products was the third-highest category for children under age 1 year; whereas, structures and fixtures (e.g., doors, windows, bathtubs) was the third-highest category for ages 2–4 years. Beds were in the top five categories of products for all ages. Other types of products such as wheeled equipment, as well as sports and recreational equipment, increased in prominence beginning at age 2.

4. Discussion

This study used nationally representative data between the years 2001 and 2013 to study fall-related TBI in children ages 0–4 years. Prior research had shown that this age group had the highest rate of fall-related TBI ED visits overall (Taylor et al., 2017: Taylor, Greenspan, Xu, & Kresnow, 2015). An annualized national estimate of 139,001 ED visits per year in this age group approximates reports from other studies examining national data during this timeframe (Taylor et al., 2015). The annual numbers increased significantly between the study years 2001 and 2013 ($p < .05$), with 182,069 ED visits occurring in 2013. The increases observed coincide with efforts to improve awareness of concussion and TBI in children as well as return to play legislation in all states across the country. Greater awareness of the importance of seeking medical care for TBI by parents may contribute to this trend. Although not statistically significant, males had a higher rate of ED visits than females, a finding that aligns with previous studies in this age group (Burrows et al., 2015; Wang et al., 2013) The majority of children were treated and released (93%). The small proportion of children hospitalized for these injuries suggests that most injuries were mild TBIs. However, the rate of injuries increased during the study time period, especially for children younger than 1 year.

The current study found a lower proportion of skull fractures and a higher proportion of internal injuries than previous studies examining ED visits in this age group (Burrows et al., 2015; Flavin et al., 2006; Gaw et al., 2017; Ibrahim et al., 2011; Wang et al., 2013) Unlike the current study, these previous studies had access to imaging data that may have aided in identifying more skull fractures (Burrows et al., 2015; Wang et al., 2013). Further, the quality and completeness of internal injury coding in this young age group was an issue noted in the most recent NEISS coding manual (Thomas & Johnson, 2015), possibly due to multiple descriptors (i.e., contusion, laceration, hemorrhage) and inconsistent verification of imaging data to confirm these conditions. In addition, previous studies found that fall height was associated with increased severity of injury for infants and toddlers (Ibrahim et al., 2011). However, fall height was not consistently provided in NEISS-AIP narratives so we were unable to investigate the role of fall height in TBI severity. Additional investigation is warranted to better understand fall-related characteristics that result in TBI among this younger age group, particularly in relation to the likelihood of skull fractures and the impact of fall height.

Overall, actions by the child accounted for a higher proportion of injuries than actions of others. Although the category of “falls” without further description was the highest for all

age groups, the next-highest causes of falls due to child actions varied by age, specifically: “rolling or climbing” prior to age 1; “climbing, tripping, or running” at 1 year of age; and “running, jumping, and tripping” between 2 and 4 years. The highest numbers of fall-related TBI ED visits occurred among children younger than 2 years, a time during development when children are vulnerable to actions by others and falling as they begin to gain independence in mobility. Another potential explanation for the higher rate observed among children < 2 years is that parents may be more likely to seek ED care for an infant or toddler following a fall, compared to an older child. Actions by others, particularly being dropped, were more prevalent for children younger than 1 year, a finding reported in a previous study (Burrows et al., 2015). Among the youngest age groups examined in this study (0–2 years), being placed on an object accounted for fall-related TBI due to actions by others. As in previous reports (Burrows et al., 2015; Gaw et al., 2017), “carry” and “drop” are the actions most consequential in younger children and require more detailed investigation. Of particular concern, these previous studies have shown that these types of falls can cause more serious head injuries in infants and toddlers.

The majority of the fall-related TBI in this cohort occurred at home, related to surfaces, structures and fixtures, furniture, and baby products. Findings from previous studies concur that falls in young children are related to floor and ground materials (Haney et al., 2010), furniture (i.e., beds, chairs; Chaudhary et al., 2018; Kurinsky, Rochette, & Smith, 2013; Wang et al., 2013); and nursery products (Gaw et al., 2017), findings likely due to the significant amount of time young children spend in their home with families. This, along with previous research (Burrows et al., 2015; Gaw et al., 2017; Mack et al., 2008; Morroongiello, McArthur & Bell, 2014; Morrongiello & Cox, 2016; Morrongiello et al., 2005; Morrongiello et al., 2004) suggests the need for home-based interventions for parents to prevent falls.

To better understand falls in young children, further consideration of both child development and parental supervision are important when designing prevention efforts. Fall-related TBI in the 0–4 year age group coincides with reaching developmental stages, such as independent mobility and exploratory behavior, at a time when children may not have developed awareness and avoidance of hazards. In particular, children ages 1–2 are beginning to have independent mobility, which can account for a higher rate of falls in this age group (Agran et al., 2003; Coronado et al., 2015; Unni et al., 2012). Environmental modifications, such as modifications of physical space to control access to hazards like gates, along with improved parental supervision in the home, can contribute to prevention of unintentional falls in this age group (Morrongiello, Ondejko, & Littlejohn, 2004). Parental supervision, an important factor in falls prevention, has been reported to differ by child age. Younger children (ages 2–3 years) are reported to be more closely supervised than older children (ages 4–5 years; Morrongiello, Corbett, McCourt, & Johnson, 2005). Prevention efforts considering both developmental and parental factors require further study to determine the impact of reducing the rate of fall-related TBI.

4.1. Study limitations

Results of this study are subject to limitations. First, NEISS–AIP includes only injuries treated in hospital EDs and excludes those treated in homes, physician offices, outpatient clinics, or those not seen for a medical evaluation. Thus, our results underestimate the total burden of fall-related TBI ED visits in this age group. In a recent study that examined point of entry for care in a large children's healthcare system, 52% of children with concussions in the 0–4 age group entered the ED for their initial injury care compared to other settings in the system (Arbogast et al., 2016). Second, NEISS–AIP provides only national estimates – not state or local estimates. Causes and circumstances of infant injuries may vary by community and location because of differences in home and community environments and practices. Third, NEISS–AIP does not provide detailed sociodemographic information; this limits our ability to analyze key factors such as socioeconomic status or family structure. Fourth, narrative descriptions are captured from healthcare provider notes of patient statements, which may result in some omissions or inaccuracies. Over three-quarters of the narratives in this study only identified that the child fell and did not contain additional information about what led to the fall. These narratives were coded as child-initiated but it is possible that there was some amount of misclassification due to missing information in the narrative about the circumstances of the fall. This may be due to the fall being unobserved, incomplete information communicated to the medical provider, or incomplete documentation in the record.

5. Conclusions

Fall-related TBI in young children represents a significant public health burden indicated by increased ED visits for fall-related TBI in an age group that has an increased opportunity for falls as well as greater risk for long-term impact from the injury. Prevention efforts that target environmental changes along with parental supervision practices to reduce fall risk are needed.

Practical applications

Young children are prone to falls and because of this may experience a traumatic brain injury. Professionals in contact with caregivers of young children can remind them to establish a safe home and be attentive to the environment when carrying young children to prevent falls. Reducing clutter on floors, and protecting children from hazards with barriers, such as safety gates on stairs, guards on windows above ground level, and guard rails on beds are prudent safety measures. Young children should be supervised at all times around fall hazards, such as stairs and playground equipment.

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Disclosure

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Biography

Juliet Haarbauer-Krupa is a Senior Health Scientist on the Traumatic Brain Injury (TBI) Team in the Division of Unintentional Injury Prevention (DUIP) at the Injury Center. As a behavioral scientist, her role on the TBI team is to devise research projects and products to better understand trends in TBI in the US and to improve health outcomes for individuals living with a TBI. She is project lead on the Report to Congress on the Management of Traumatic Brain Injury in Children and the Return to School Projects in the division. Recent publications report a national prevalence estimate and associated health conditions of parent reported TBI in children, life expectancy and unemployment outcomes for moderate to severe TBI, outcomes of young children who experienced a TBI before age 5 years, point of healthcare entry for children with concussions, talking to young children about concussions, improving clinical practice for concussion diagnosis, and service delivery systems for children with TBI. Dr. Haarbauer-Krupa has 30 years of experience and has authored over 30 publications and given multiple presentations in the area of traumatic brain injury with specialties in rehabilitation and pediatric populations. She currently holds an adjunct position in the Department of Pediatrics, Emory University School of Medicine.

Tadesse Haileyesus is a mathematical statistician in the Division of Analysis, Research and Practice Integration, National Center for Injury Prevention and Control, Centers for Disease Control and Prevention, Atlanta, GA. He has numerous publications in the area of injuries and injury prevention.

Julie Gilchrist is a pediatrician and researcher who recently retired after more than 20 years with CDC’s Injury Center. She graduated from Rice University, attended UT South-western Medical School and completed her pediatrics residency at Children’s Hospital of Philadelphia. She came to CDC in 1997 as an Epidemic Intelligence Service Officer. In her time at the Injury Center, Dr. Gilchrist was responsible for research and programmatic efforts to prevent common childhood injuries such as drowning, concussion and other sports injuries. She is now consulting with CDC’s National Center on Birth Defects and Developmental Disabilities to assist with their efforts to prevent neonatal abstinence syndrome.

Karin A. Mack is the Associate Director for Science (ADS) for the Division of Analysis, Research and Practice Integration (DARPI) in the National Center for Injury Prevention and Control (NCIPC). As the ADS, she provides leadership to DARPI management and staff on scientific activities and research methodologies. Her research activities focus primarily on the topics of prescription drug overdose prevention, population level change to reduce injuries, and healthy and safe homes. She received her Bachelor of Arts degree in Socioeconomics from James Madison College of Michigan State University, her Master of Science and Doctoral degrees in Sociology (Demography, and Gender, Work, and Family) from the University of Maryland, College Park. In 1997, Dr. Mack began her career at CDC in NCCDPHP as an Epidemiologist with the Behavioral Risk Factor Surveillance System (BRFSS). She joined NCIPC in 2003 as a Senior Behavioral Scientist for the Home & Recreation Team where she worked on fall prevention, healthy and safe homes, and child injury prevention. She was part of the Prescription Drug Overdose Team that was formed in

late 2012 to address the growing epidemic of drug overdoses. In addition to her work at CDC, she is an adjunct faculty member in Emory University's Sociology Department.

Caitlin S. Law at the time of this project was an intern from the Department of Public Health, Emory University, Atlanta, GA working under the supervision of Dr. Juliet Haarbauer-Krupa on the TBI Team in the Division of Unintentional Injury, CDC. Currently she is an Epidemiologist for Surveillance Systems and Informatics for the State of Tennessee.

Andrew Joseph at the time of this project was an intern from the Department of Biomedical Engineering at Georgia Institute of Technology, Atlanta, GA working under the supervision of Dr. Juliet Haarbauer-Krupa on the TBI Team in the Division of Unintentional Injury, CDC. Currently he is enrolled in medical school at Nova Southeastern College of Osteopathic Medicine.

Abbreviations:

TBI	Traumatic Brain Injury
ED	emergency department
ICD-9	International Classification of Diseases-9
NEISS-AIP	National Electronic Injury Surveillance System–All Injury Program
CDC	Centers for Disease Control and Prevention
CPSC	US Consumer Product and Safety Commission
APC	Annual Percentage Change

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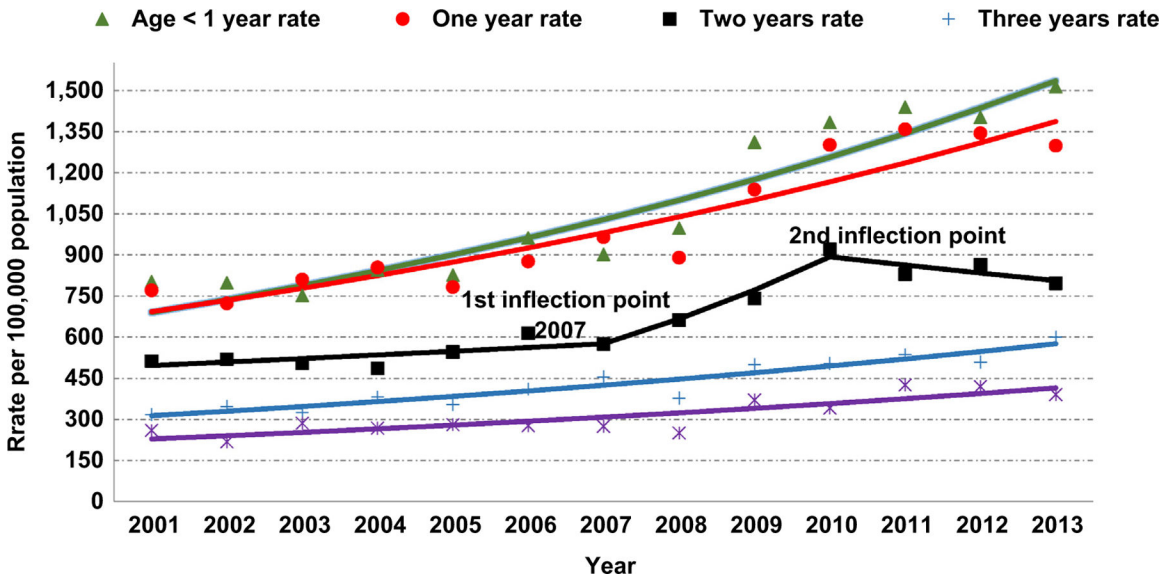

Fig. 1.

Nonfatal fall-related traumatic brain injury rates among children age 0–4 years treated in US emergency departments - National Electronic Injury Surveillance System–All Injury Program, by year and age, 2001–2013. There is no inflection point from 2001 to 2013, for age < 1 year children and annual percentage change (APC) = 6.9*; for age one year APC = 5.9*, for age three APC = 5.2*, and for age four APC = 5.1*. For two year old children from 2001 to 2007 APC = 2.5 from 2007 to 2010 APC = 15.7 and from 2010 to 2013 APC = −3.4. * Indicates statistical significance of joinpoint results (p-value < .05).

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Table 1

Non-fatal fall-related traumatic brain injuries among children age 0–4 years treated in US emergency departments, National Electronic Injury Surveillance System–All Injury Program, 2001–2013

	Sample cases (n)	Annualized national estimate[b]	Percent	Rate[a]	Rate[a] 95% confidence interval		
Total	**47,355**	**139,001**	**100.0**	**698.32**	**503.51**	**–**	**893.14**
Diagnosis							
Concussion	3910	13,286	9.6	66.74	49.30	–	84.19
Fracture	1630	3766	2.7	18.92	13.43	–	24.41
Internal injury	41,815	121,950	87.7	612.66	434.46	–	790.86
Disposition							
Treated and released	43,287	129,278	93.0	649.47	467.32	–	831.63
Hospitalized/transferred	2611	6906	5.0	34.70	23.44	–	45.96
Other/unknown	1457	2817	2.0	14.15	6.34	–	21.97
Age (years)							
<1	15,302	42,840	30.8	1069.99	743.41	–	1396.58
1	13,441	40,178	28.9	1009.19	737.79	–	1280.59
2	8701	26,285	18.9	661.52	480.31	–	842.73
3	5799	17,219	12.4	433.77	313.82	–	553.71
4	4112	12,479	9.0	313.78	226.03	–	401.53
Sex							
Male	26,457	77,591	55.8	762.87	555.57	–	970.17
Female	20,898	61,410	44.2	630.88	448.28	–	813.47
Race/ethnicity[c]							
White, non-Hispanic	18,979	65,986	47.5	.			
Black	6999	14,566	10.5	.			
Hispanic	6101	17,570	12.6	.			

	Sample cases (n)	Annualized national estimate[b]	Percent	Rate[a]	Rate[a] 95% confidence interval		
Total	**47,355**	**139,001**	**100.0**	**698.32**	**503.51**	**–**	**893.14**
Other, non-Hispanic	1776	5581	4.0	.			
Unknown	13,500	35,299	25.4	.			
Location							
Home/apartment/mobile home	39,505	116,042	83.5	582.98	416.30	–	749.66
Street/public area	5075	15,144	10.9	76.08	56.12	–	96.05
School	1347	3669	2.6	18.43	12.61	–	24.25
Sports	1409	4067	2.9	20.43	14.00	–	26.86
Other/Unknown[b]	19	79	0.1	.			
Year							
2001	2863	103,432	5.7	535.97	351.60	–	720.33
2002	3034	102,035	5.6	525.16	375.21	–	675.12
2003	2897	105,516	5.8	538.56	387.84	–	689.28
2004	3018	112,590	6.2	569.04	382.70	–	755.38
2005	3127	111,166	6.2	558.14	387.81	–	728.46
2006	3230	125,529	6.9	629.57	433.90	–	825.24
2007	3157	128,140	7.1	636.69	427.32	–	846.06
2008	3566	129,451	7.2	638.60	439.19	–	838.01
2009	4732	164,421	9.1	812.18	555.32	–	1069.04
2010	4793	178,720	9.9	884.69	615.41	–	1153.97
2011	4326	183,443	10.2	911.47	602.86	–	1220.09
2012	4338	180,507	10.0	903.41	583.75	–	1223.07
2013	4274	182,069	10.1	917.04	568.35	–	1265.74

[a] Rate per 100,000 population.

[b] Weighted estimates. Estimates with sample cases of < 20, national estimate of < 1200 or coefficients of variation N30% are considered unstable, and resulting rates are not reported.

[c] Due to a high percentage (25%) of unknowns, rates by Race/Ethnicity are not reported. “Black” includes Hispanic and non-Hispanic blacks; “Hispanic” excludes black Hispanics.

Table 2

Nonfatal fall-related traumatic brain injuries among children ages 0–4 years treated in US emergency departments by action and age - National Electronic Injury Surveillance System–All Injury Program, 2001–2013.

	<1 year	1 year	2 years	3 years	4 years	Total
Rank	Action by child, Column Percent, (weighted n)					
1	Fall 85.4 (416,292)	Fall 82.4 (418,826)	Fall 77.9 (261,227)	Fall 75.2 (165,799)	Fall 74.0 (117,835)	Fall 80.7 (1,379,978)
2	Roll 11.8 (57,705)	Trip 4.3 (21,620)	Run 5.1 (17,251)	Jump 5.6 (12,355)	Jump 5.3 (8398)	Roll 4.1 (70,823)
3	Climb 0.8 (3834)	Run 3.9 (19,815)	Jump 3.8 (12,617)	Run 5.2 (11,364)	Trip 5.0 (7888)	Trip 3.1 (52,561)
4	Trip 0.5 (2574)	Climb 2.5 (12,810)	Trip 3.7 (12,308)	Trip 3.7 (8170)	Run 4.7 (7539)	Run 3.3 (57,146)
5	Slip 0.5 (2430)	Slip 1.5 (7701)	Climb 2.5 (8448)	Climb 2.9 (6370)	Slip 3.6 (5786)	Jump 2.3 (40,014)
6	Run 0.2 (1176)	Roll 1.5 (7645)	Slip 2.4 (7899)	Slip 2.5 (5553)	Climb 2.5 (4023)	Climb 2.1 (35,486)
7	Play 0.2 (1175)	Stand 1.4 (6961)	Stand 1.9 (6330)	Play 2.3 (5124)	Play 3.2 (5111)	Slip 1.7 (29,370)
8	Stand 0.3 (1460)	Play 1.3 (6507)	Play 1.7 (5670)	Stand 1.5 (3410)	Stand 1.3 (2021)	Play 1.4 (23,586)
9	Jump 0.1 (571)	Jump 1.2 (6074)	Roll 1.0 (3248)	Roll 0.7 (1588)	Roll 0.4 (636)	Stand 1.2 (20,183)
10	Get 0.0 (132)	Get 0.1 (302)	Step 0.1 (273)	Get 0.2 (424)	Get 0.0 (29)	Get 0.1 (1157)
11	Drop 0.0 (8)	Step 0.0 (135)	Get 0.1 (269)	Step 0.1 (285)	Step 0.0 (10)	Step 0.0 (703)
12						Drop 0.0 (8)
Subtotal	487,356	508,397	335,540	220,443	159,276	1,711,012
	100.0	100.0	100.0	100.0	100.0	100.0
Rank	Action by other, Column Percent, (weighted n)					
1	Drop 63.2 (44,001)	Drop 60.5 (8424)	Drop 57.4 (3541)	Drop 52.0 (1770)	Drop 44.6 (1315)	Drop 61.5 (59,051)
2	Carry 29.1 (20,257)	Carry 22.7 (3158)	Carry 26.0 (1603)	Push 27.3 (928)	Push 43.8 (1290)	Carry 27.0 (25,962)
3	Placed 3.8 (2664)	Push 13.2 (1841)	Push 13.4 (828)	Carry 19.0 (645)	Carry 10.2 (300)	Push 6.8 (6535)
4	Push 2.4 (1648)	Placed 2.8 (388)	Pull 2.4 (151)	Pull 1.2 (42)	Pull 1.5 (43)	Placed 3.2 (3101)
5	Pull 1.4 (973)	Pull 0.8 (105)	Placed 0.6 (40)	Placed 0.2 (8)		Pull 1.4 (1314)
6	Throw 0.0 (27)		Throw 0.1 (8)	Throw 0.3 (9)		Throw 0.0 (43)
Subtotal	69,570	13,917	6170	3402	2948	96,007
	100.0	100.0	100.0	100.0	100.0	100.0
Total (weighted n)	556,926	522,314	341,710	223,845	162,224	1,807,019

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Table 3

Products involved with nonfatal fall-related traumatic brain injuries among children ages 0–4 years treated in US emergency departments - National Electronic Injury Surveillance System– All Injury Program, 2001–2013.

Rank	<1 year	n*	%	1 year	n*	%	2 years	n*	%	3 years	n*	%	4 years	n*	%
1	Surface	327,438	37.1	Surface	209,308	29.2	Surface	124,358	27.0	Surface	73,760	24.8	Surface	51,492	24.9
2	Bed	192,905	21.9	Furniture	154,378	21.6	Furniture	104,477	22.7	Furniture	68,686	23.1	Furniture	42,467	20.5
3	Furniture	128,016	14.5	Structure/fixture	148,002	20.7	Structure/fixture	86,833	18.9	Structure/fixture	52,731	17.7	Structure/fixture	36,572	17.7
4	Baby/child product	114,378	13.0	Bed	75,722	10.6	Bed	51,716	11.2	Bed	34,515	11.6	Sport & Rec	26,439	12.8
5	Structure/fixture	65,358	7.4	Baby/child product	31,375	4.4	Wheeled equipment	32,323	7.0	Sport & Rec	26,575	8.9	Bed	25,099	12.1
6	Wheeled equipment	16,550	1.9	Wheeled equipment	31,041	4.3	Sport & Rec	20,052	4.4	Wheeled equipment	16,207	5.5	Wheeled equipment	8106	3.9
7	Crib	16,513	1.9	Crib	15,949	2.2	Toy	10,183	2.2	Toy	6824	2.3	Toy	5550	2.7
8	Toy	4579	0.5	Sport & Rec	15,605	2.2	Baby/child product	8875	1.9	Equipment	4695	1.6	Equipment	3572	1.7
9	Equipment	3868	0.4	Toy	12,616	1.8	Equipment	5411	1.2	Baby/child product	3339	1.1	Misc household item	1592	0.8
10	Sport & Rec	3573	0.4	Equipment	6579	0.9	Crib	4314	0.9	Misc household item	2793	0.9	Baby/child product	1281	0.6
11	Misc house-hold item	2114	0.2	Misc household item	3118	0.4	Misc household item	2487	0.5	Container	2013	0.7	Container	1265	0.6
12	Appliance	1694	0.2	Electronic	2596	0.4	Electronic	2228	0.5	Clothing	1186	0.4	Animal induced	1257	0.6
13	Animal induced	1669	0.2	Clothing	2543	0.4	Container	1927	0.4	Appliance	1037	0.3	Electronic	999	0.5
14	Electronic	1378	0.2	Animal induced	2367	0.3	Animal induced	1580	0.3	Electronic	990	0.3	Clothing	741	0.4
15	Container	1201	0.1	Appliance	2269	0.3	Appliance	1554	0.3	Animal induced	963	0.3	Appliance	551	0.3
16	Clothing	878	0.1	Container	2173	0.3	Clothing	1554	0.3	Crib	618	0.2	Tools	98	0.0
17	Tools	145	0.0	Tools	316	0.0	Tools	232	0.1	Tools	168	0.1	Crib	77	0.0
18	Weapon	32	0.0												

*Product categories are not mutually exclusive – more than one product could have been involved in the fall. Sports and rec indicates sports equipment in the house.