Patterns of Injury Associated With Routine Childhood Falls

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Objective: To identify the pattern of injuries associated with routine childhood falls.

Methods: Retrospective chart review of patients at most 12 years presenting to a children's hospital emergency department with complaint of a fall. Patients were classified into 3 age groups (<2, 2–4, and 5–12 years) and analyzed for the type of fall and diagnosis.

Results: Seven hundred eighty-seven patients were enrolled. Mean age was 5.7 years. Fifty-six percent were boys. The types of falls reported were categorized as a fall down steps, from patient's own height, from an object, and other. In all 3 groups, the most common fall was fall from an object (50%, 50%, and 48%, respectively). There were 91 (12%) patients in the younger-than-2-year-old age group and 235 (30%) in the 2- to 4-year-old age group. Both groups commonly fell from a bed/chair (35% and 25%, respectively). In the youngest group, the most frequent diagnosis was head injury (41%; odds ratio [OR], 5.0; 95% confidence interval [CI], 3.0–8.1). Children ages 5 to 12 years numbered 461 (58%) and most commonly fell from playground equipment (26%) sustaining a fracture (65%; OR, 3.1; 95% CI, 2.3–4.3). Of these, 77% were in the upper extremity (arm fracture; OR, 41; 95% CI, 22–79).

Conclusions: In children who presented to a children's hospital emergency department with a fall, fall from an object was the most common type. Those younger than 2 years, most commonly fell from a bed/chair and sustained head injury. Children 5 to 12 years old were likely to fall from playground equipment and fracture their arm. These findings may be helpful to clinicians who evaluate routine childhood falls.

Key Words: childhood, falls, injury

Falls are a leading cause of childhood injury.[1] In developed countries, injury is responsible for most childhood morbidity and mortality[2] and thus represents a large burden to the health care system. In one pediatric study, for each injury-related death, there were 19 hospitalizations and 300 emergency department (ED) visits.[3] In a general study of ED usage, 7,946,000 ED visits per year were because of falls. Children younger than 5 years made up 14% of those visits, comprising the largest group.[4] Level I trauma centers generate a large amount of data. However, these data describe the most serious injuries and represent only a small percentage of the injuries sustained by children.[5] Primary care visits are the setting for a large number of pediatric injury evaluations as well. More than 10 million primary care visits per year are injury-related.[6]

Recently, a population-based study followed nearly 10,000 children from infancy to 5 years old. The data concluded that there are patterns of injury at different ages, recurrent injury is common, and ED and primary care visits are proportional.[7] Thus, identifying specific injury patterns observed in children can help in preventing future injury. Also, knowledge gained from the ED setting can be of practical use in the primary care setting as well.

Therefore, the purpose of this study was to identify the pattern of injuries associated with routine childhood falls of various mechanisms presenting to a children's hospital ED as a representative population of the ambulatory community.

METHODS

Study Design

Charts of all children younger than 13 years with a fall-related complaint presenting to the pediatric ED of a suburban academic children's hospital between June 2001 and December 2001 were reviewed retrospectively. *International Classification of Diseases, Ninth Edition* code 888.9 or unspecified fall/fall not otherwise specified identified eligible patients. During this period, the full-time coder for the ED was routinely indicating this type of complaint if indicated in the record in addition to the diagnosis code provided by the treating physician. Two individuals extracted data from standard dictated attending records on the following points: demographics, event history, workup performed, diagnosis, treatment, and follow-up plan. These data points were entered into a database in SPSS version 11.5 for Windows (SPSS Inc, Chicago, IL). This study was reviewed by the hospital's Institutional Review Board and was approved by expedited review.

Study Setting

This study was conducted at a suburban, tertiary care, academic children's hospital with approximately 30,000 annual visits. It is a participating trauma center and is staffed by pediatric emergency medicine physicians 24 hours a day as well as pediatric, emergency medicine, and family medicine residents. Every patient is evaluated during their ED stay by a pediatric emergency medicine attending physician who provides a standardized and dictated record.

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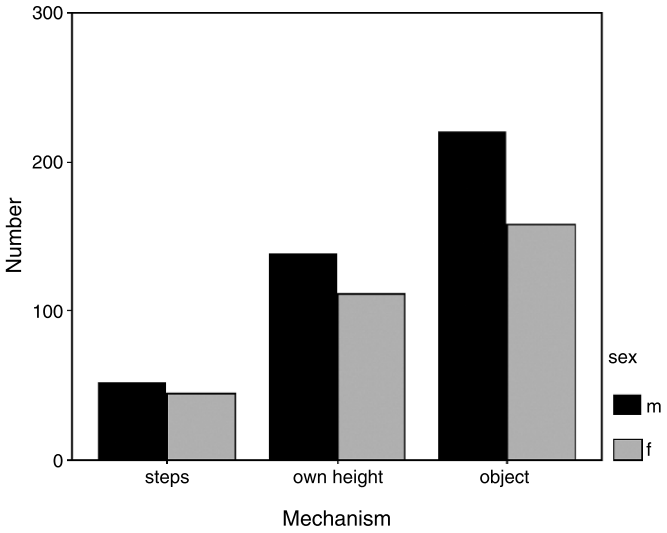

FIGURE 1. Mechanisms of injury by sex.

Study Protocol and Outcome Measures

Patients were first classified in 3 age groups: younger than 2 years, 2 to 4 years, and 5 to 12 years. The falls were also categorized as follows: down the stairs, from own height, and from an object. In addition, specific objects from which the children fell were recorded if specified. Diagnoses were coded into soft tissue injury, fracture, head injury, dental injury, and no injury identifiable. The area of the body injured was also noted. Injuries were recorded by primary and secondary diagnosis given by the treating physician. For example, forehead laceration represents soft tissue injury as a primary diagnosis and head injury as a secondary diagnosis. Those injuries and mechanisms not fitting the above categories were classified as other.

Fall types were stratified by severity of injury based on the intervention necessary as follows: those with no intervention necessary (minimal severity, 0); splint or laceration repair (minor severity, 1); fracture/dislocation reduction, admission, head injury requiring a head computed tomography or complicated fractures, such as femoral, supracondylar, and open fracture (significant severity, 2). This severity stratification was compared with the number of steps fallen.

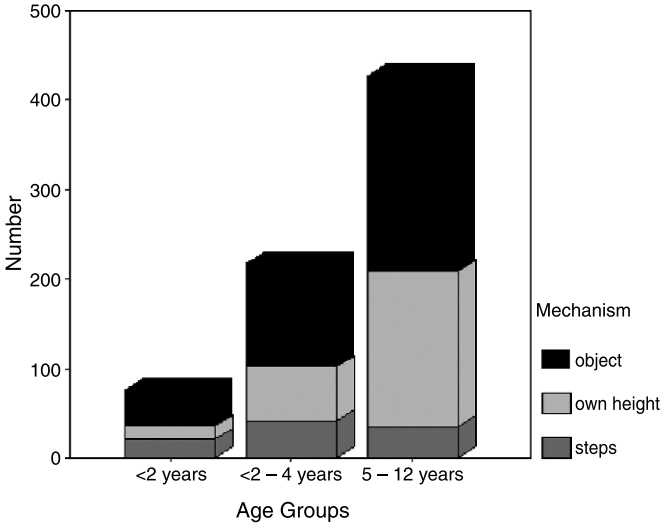

FIGURE 2. Mechanism of injury by age group.

TABLE 1. Most Common Descriptions of Mechanism

Mechanism Specifics	%
Own height	32
Monkey bars	18
Bed/chair	15
Steps	11
Tree/pole	3
Trampoline	3
Scooter	3
Crib/high chair	2
Dropped	2
Shopping cart	1
Other	10

Statistical Analysis

Injury frequencies were graphed for each age group. Descriptive statistics, χ^2 test and odds ratio (OR), were then performed. ROC curves were generated, and the falls were dichotomized into those with high versus low risk for injury according to number of steps. Also, severity stratification was used in the comparison of radiological studies obtained and rates of positive findings.

RESULTS

Seven hundred eighty-seven patients fit coding criteria. Charts were obtained for all patients identified. Fifty-six percent were boys. The mean age was 5.7 years (SD, 3.4 years).

The median age was 5 years (range, 1.5 months to 12 years). There were 91 (12%) patients in the younger-than-2-year-old age group and 235 (30%) in the 2- to 4-year-old age group. Children aged 5 to 12 years numbered 461 (58%). The mechanisms of injuries reported were categorized as a fall down steps (13%), a fall from patient's own height (32%), a fall from an object (48%), and other (6%). In all 3 age groups, the most common type of fall was fall from an object

TABLE 2. Most Common Locations of Injury

Location of Injury	%
Upper extremity	40
Head/face	34
Lower extremity	8
Ankle/foot	6
Wrist/hand	5
Neck/shoulder	4

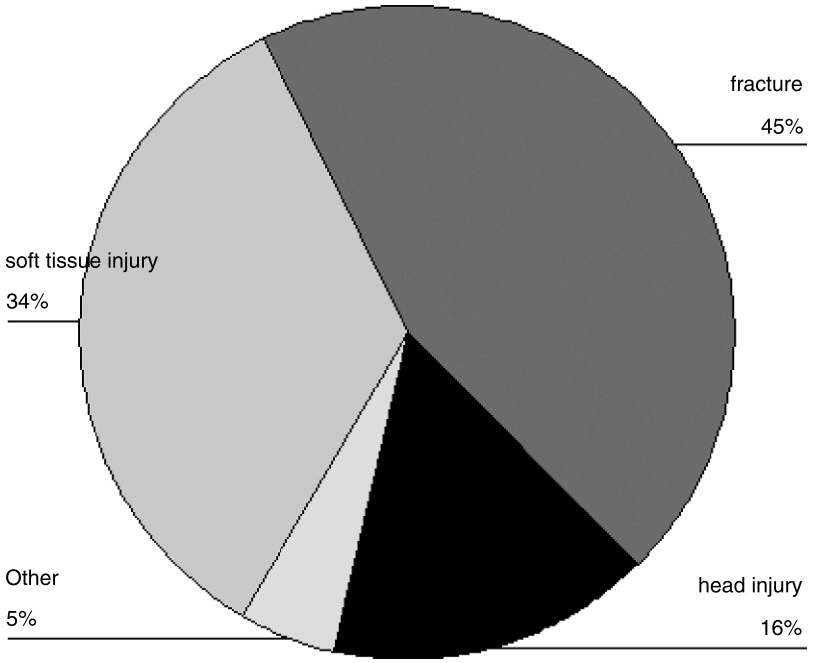

FIGURE 3. Primary diagnosis given by the treating physician.

(50%, 50%, and 48%, respectively). Figures 1 and 2 show mechanism of injury by sex and age group, respectively.

Details of the specific mechanism of injury were also examined. The younger-than-2-year-old age group and the 2- to 4-year-old age group most commonly fell from a bed/chair (35% and 25%, respectively). Children ages 5 to 12 years most commonly fell from playground equipment (26%). Table 1 shows the specifics of the fall mechanisms. The location of the body that sustained the injury is shown in Table 2.

Analysis of the injuries was based on the primary diagnosis given by the treating physician. The predominant diagnoses given are shown in Figure 3. Notably, when secondary diagnosis of head injury was considered, the incidence of head injury increased from 16% to 23%.

In the youngest group, the most frequent diagnosis was head injury (41%). Patients in this group were more likely to be diagnosed with head injury than the other groups (OR, 5.0; 95% confidence interval [CI], 3.0–8.1). One infant sustained a nondisplaced skull fracture. No intracranial hemorrhages were identified. No patients required neurosurgical intervention (Fig. 4).

This group was further evaluated for potential abuse-related injuries. There were 22 fractures and 41 head injuries.

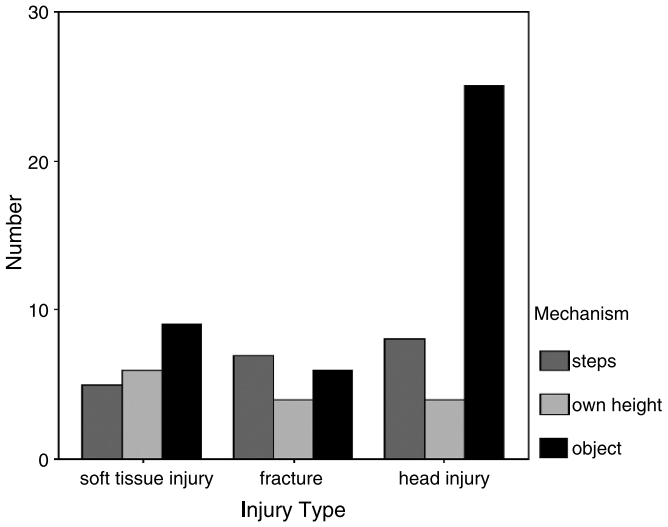

FIGURE 4. Age group, younger than 2 years: injury type by mechanism.

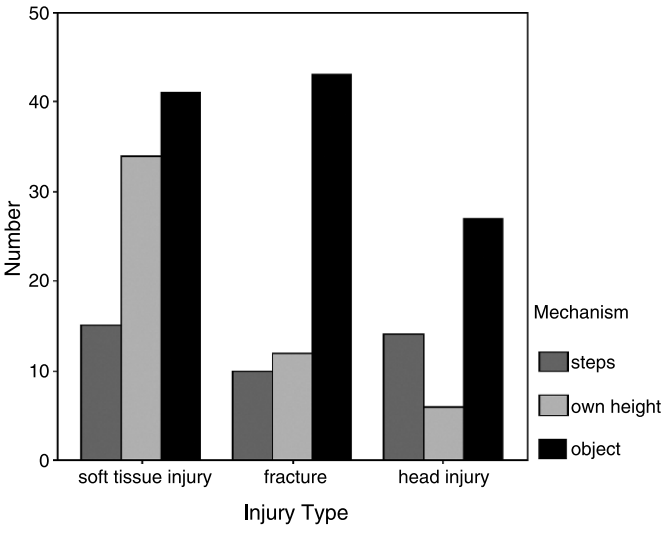

FIGURE 5. Age group, 2 to 4 years: injury by mechanism.

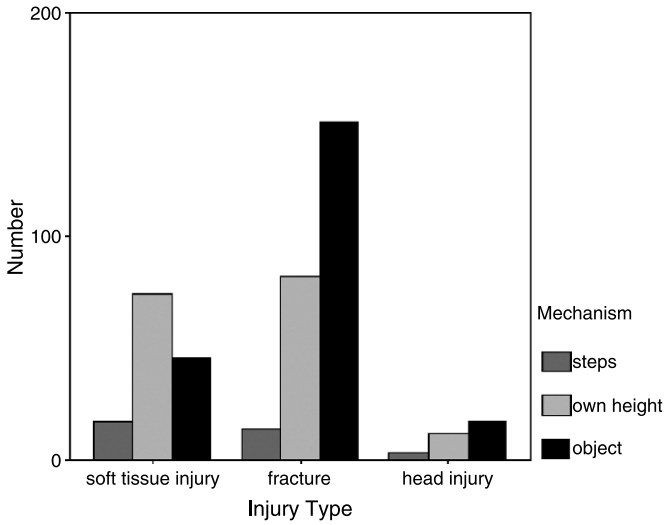

FIGURE 6. Age group, 5 to 12 years: injury type by mechanism.

Eight fractures were clearly not abuse-related (6 buckle, 2 toddler's fractures). There were 3 femur fractures. Two were determined by ED attending physician to have no suggestion of abuse. One was admitted and had an evaluation by the Child Abuse Reduction and Enforcement team (specialized social work with an expert physician in child abuse), which determined no indications of child maltreatment. Neither a patient with a parietal skull fracture nor one with a subgaleal hematoma had suspicion of child abuse as determined by the treating physician.

Children 2 to 4 years old falling from their own height were twice as likely to sustain soft tissue injury than other types of injuries (OR, 2.4; 95% CI, 1.3–4.3) (Fig. 5). In the oldest age group, the most frequent diagnosis was fracture (65%; OR, 3.1; 95% CI, 2.3–4.3). Of these, 77% were in the upper extremity (arm fracture; OR, 41; 95% CI, 22–79) (Fig. 6).

TABLE 3. Rates of Radiographs Performed and Positive Results by Severity Levels

	Minimal (0)	Minor (1)	Significant (2)
Radiographs ordered	87 (34%)	298 (75%)	131 (99%)
Positive radiographs	2 (<1%)	226 (76%)	110 (84%)

None of the groups showed a significant pattern of injury after a fall down the stairs. Admissions made up 2.4% (19 patients) and included 9 femur fractures, 4 head injuries, and 6 arm/elbow fractures. Figure 7 shows the proportion of various interventions required. None of the groups had patients excluded for reasons of child abuse. No reports of potential abuse were made to a welfare agency in this population of patients.

Using the severity of injury stratification, an ROC curve was generated to address whether an assignment of high versus low risk for injury can be made based on the number of steps reported. For number of steps, there was no association between the number of steps and the severity of injury (area under the curve, 0.5; 95% CI, 0.3–0.6). The data did not support a valid analysis of the height of fall from an object because of the small number of cases containing this information accurately.

Assessment of the ordering of radiographs and computed tomography studies was made based on the severity stratification. Rates of radiographs performed and positive results by severity scoring are shown in Table 3. At

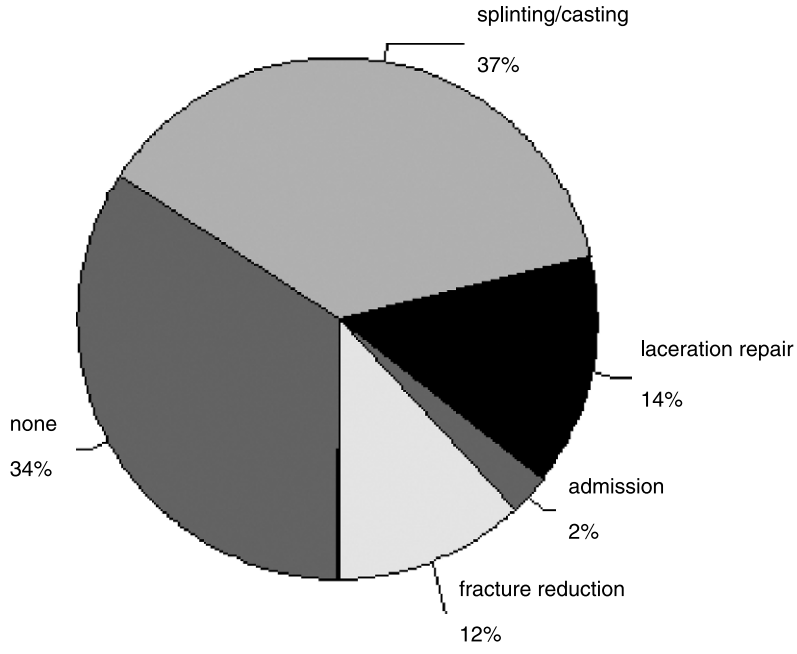

FIGURE 7. Interventions performed.

the higher severity levels, the proportion of cases with radiographs performed and the rate of positive results both increased.

DISCUSSION

Injury research helps the health care of children on many fronts. Prevention is possible through identification and education on exposures that pose significant risk. For example, injuries from burns,[8] ingestions,[8] sports,[9,10] and walkers,[11] were all reduced because of identification and prevention measures. Also, research allows pattern development, helping health care personnel who treat children to recognize, for example, accidental versus nonaccidental injury.[12]

The scenario of children presenting to a physician after a fall but having no documented injury is a common occurrence. However, our data express a small number of children with no injury found. Other studies have shown similar rates of injuries in such situations.[13] This may represent 2 types of bias, sampling bias and coding bias. First, a sampling bias may be generated by the parents self-selecting their children for presentation to an ED.[14] This may be because they have recognized injury due to outward physical findings (bruises, abrasions, etc) or have concern over mechanism prompting the evaluation. Those without physical symptoms may not have presented for evaluation or been seen in their primary care office. Another form of bias may be secondary to the coding process. After an ED visit, a diagnosis is required for coding. A patient may receive the nonspecific diagnosis of head injury based on history and mechanism only despite the lack of physical findings. In further analysis of this group, we found that most (65%) patients with head injury received a severity code of zero (minimal/no injury). In other words, most head injuries required no interventions or studies, suggesting their findings were minimal or none.

As previously described in other studies, none of the groups showed a significant pattern of injury after a fall down the stairs.[15] In addition, the injury sustained was not severe, which is also in agreement with prior work.[2]

Our findings are plausible based on developmental stages and body proportions of the groups. These data may assist clinicians who evaluate routine childhood falls by suggesting clinical findings to be expected after certain falls.

LIMITATIONS

This study was limited by its retrospective design. The history provided did not always contain detailed descriptions of mechanism, that is, number of steps or feet fallen. However, the data were abstracted from dictated pediatric emergency medicine attending records, representing the best possible data acquisition in a retrospective study such as this one. The design also did not allow for patient follow-up to assess for missed injuries.

CONCLUSIONS

This population demonstrated injury patterns similar to those accepted in the literature. Routine household falls generated little or insignificant injury. Falls from the stairs and furniture were relatively low risk for injury. Fall from an object was the most common mechanism of injury. The following patterns were observed in our population: (1) those younger than 2 years sustained only mild head injury secondary to fall from bed/chair; (2) those 2 to 4 years old demonstrated soft tissue injury after a fall from their own height; (3) those 5 to 12 years old most commonly sustained an arm fracture falling from playground equipment. These data contribute to the growing knowledge of pediatric traumatic injury and may help medical professionals to understand, anticipate, and prevent childhood injuries.

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