Characteristics of household falls in children under 2 years of age

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SUMMARY: Oral R, Floryanovich A, Goodman J, Türkmen M. Characteristics of household falls in children under 2 years of age. Turk J Pediatr 2007; 49: 379-384.

We hypothesized that young children uncommonly acquire significant injuries due to household falls that necessitate medical attention.

Data on recalled fall experiences were collected from parents of children younger than two years visiting the University Pediatrics Clinic. Statistical analysis was performed using Student's t test and chi square test.

Of 573 children, 36% experienced no falls, while 64% experienced 782 falls. Eleven percent of falls occurred from a distance of three to five feet (~90-150 cm). In 6% of all falls, medical care was sought. In 40% of this subcategory, examination was normal; in 33%, medical work-up revealed normal results; in 23%, injuries necessitated subsequent intervention. No fall led to neurological findings.

This study supports that it is uncommon for household falls to cause injuries significant enough to require professional medical care. Even falls from a distance of greater than three feet result in only mild injury with no neurological findings.

Key words: household falls, population survey, injury, child.

Injuries in children are a leading cause of morbidity and mortality in the United States. Falls frequently result in emergency room visits and are the fourth leading cause of trauma deaths[1]. Researchers have looked into the consequences of falls in children from an epidemiological perspective. There is an abundant literature reporting on the spectrum of falls in children presenting to medical facilities with an injury[1-4]. Although home is the primary place for injuries, especially in children younger than two years of age[1], the existing literature is lacking with regard to reports on the consequences of the full spectrum of household falls.

We were able to find only one study that collected data about the type of fall, distance fallen, resulting injury, and help sought for children at six months of age. This study, conducted via mailed questionnaire, concluded that falls in infants are common but injuries are rare. Serious injury in the form of skull fractures, concussion, and soft tissue injuries reportedly occurred in only 0.2% of all infants, despite the fact that 95% of injuries involved the head[6]. In another study, Agran et al.[7] also reported that falls were the major mechanism of injury in toddlers.

Having baseline data on the rate and consequences of household falls within the general population of young children would be most helpful in assessing cases of suspected child abuse and neglect. Such data would provide a context for viewing cases of non-trivial falls in the household setting. The absence of such estimates poses legal problems involving the medico-legal management of suspected cases of child maltreatment.

In response to the scarcity of such studies in the general population, we conducted a survey of parents with children two years of age and younger. We hypothesized it was uncommon that young children acquire significant enough injuries to necessitate medical attention due to household falls.

Material and Methods

This study was conducted at the University of Iowa Family Care Center Pediatric Outpatient Clinic between 7/15/2003 and 8/15/2004 to investigate the full spectrum of memorable falls, related consequences, and need for medical attention after a fall. The study was approved by the Institutional Review Board. The study sample consisted of a convenience sample of all families with children two years of age or younger scheduled for a health maintenance visit at the Clinic. An investigator contacted parents at the time of registration, explained the study, and obtained written consent from those interested in participating. The investigator then either presented a questionnaire to the parents to complete and return during the course of the appointment or interviewed the subjects face to face using the same questionnaire. The questionnaire obtained data on the child's age, number of memorable falls experienced, and the details of each fall, such as age at the time of fall, distance fallen, resultant injuries, and need for medical care. If the child had more than one memorable fall or if the family had more than one child in this age range, a separate questionnaire was completed for each individual child and fall.

The hospital database was reviewed to verify subsequent medical visits that followed the reported falls. There was no discrepancy between parental reports and the database data on medical visits. "Memorable fall" was described as one with either of the following features: a) Child was symptomatic with bleeding, loss of consciousness, vomiting, prolonged pain, refusal to use extremity, or soft tissue injury, and b) Child was asymptomatic but parent was worried child might have subtle injury due to impact to the head or distance fallen.

Fall rate was reported both cumulatively and in quarter-year intervals (inclusive), as 0-3, 4-6, 7-9, 10-12, 13-15, 16-18, 19-21, and 22-24-month intervals.

Two software programs were used for the descriptive and comparative statistical analysis of the data. Microsoft Excel software was used for data entry and comparison of continuous variables between groups was done via Student's t test. For categorical variables, contingency tables were created and statistical analysis was performed using Minitab software via chi square test.

Results

Of the 618 families approached, 573 (93%) agreed to participate in the study. Every family had one child in the study age range.

A total of 204 (36%) children experienced no significant falls. Three hundred and sixty- nine (64%) subjects had experienced at least one memorable fall. Of these, only three (1% of those who fell) had fallen when they were younger than four months old: one child fell from a couch, another fell off a bed, and a third fell off her mother's abdomen while the mother was sleeping on the floor. All three falls were from a distance of less than three feet.

The remainder 366 subjects had experienced the falls when they were aged four months or older. There was no gender distribution difference between the groups of infants based on the presence of fall history.

When fall rate was examined by quarter-year intervals, a very small number of infants had experienced a fall between 0-3 months of age. Memorable fall rate gradually increased from 4-6 months of age, peaking at the 16-18 months of age interval (Table I).

Table I. Quarter-Year Interval Age Distribution of Subjects at the Time of a Memorable Fall

Age interval (months, inclusive)	# of falls (N=782)	% of falls (n/782)
0-3	3	0.4
4-6	53	6.8
7-9	79	10.1
10-12	104	13.3
13-15	151	19.3
16-18	168	21.5
19-21	141	18.0
22-24	83	10.6

The majority of parents stated that as soon as their children began walking they "fell all the time." Three hundred sixty-nine subjects experienced a total of 782 memorable falls. The single most common cause of a fall was tripping while walking or running, amounting to 27% of reported falls. Falling from furniture was the second most common mechanism of a fall. The manner and location of all reported falls are shown in Table II.

Eleven percent (84/782) of all falls involved a fall distance of three to five feet (90-150 cm); 89% occurred from less than three feet

Table II. The Manner and Location of the 782 Falls Experienced by 369 Subjects

	Fall distance			
	<3 ft		>3 ft	
Fall Type	n	%	n	%
Walking/running	214	27		
Off a bed*	85	11	26	3
Down stairs	79	10		
From a couch*	62	8	6	1
Tipping while seated	48	6		
Attempting to stand	50	6		
From a chair*	33	4	5	1
From a crib	2	0	7	1
Off a counter			8	1
Changing table/table			7	1
Standing adult's arms			5	1
High chair			4	1
Other	125	16	16	2
Total	698	89	84	11

* When these items accounted for a fall from more than three feet, the fall took place over the head of a bed, or back of a chair or a sofa.

(90 cm). The most common falls from greater than three feet were: off a bed (31%), from chairs (10%), off a counter (10%), and from a crib (8%). The rest of the falls were from a changing table or high table (8%), couch (7%), and from a standing adult's arms (6%).

Six percent (48/782) of fall episodes prompted seeking medical care. In two children the outcome of the medical visit was not documented. One of these children had jumped off a chair and was limping. The second child fell off a recliner with subsequent refusal to use her injured arm. In 19 of these fall episodes (40%) in which medical care was sought, physical examination was normal and there was no intervention other than recommending watchful monitoring at home. These episodes accounted for 2.4% of all falls. Sixteen fall episodes (33% of falls prompting medical care) led to a medical work-up that revealed no abnormality. These accounted for 2% of all falls. X–rays and computerized tomography (CT) scans of the head were taken in 39% (14/48) and 8% (4/48) of the falls, respectively, that required medical attention (2 falls required both an X-ray and a CT scan). Only 11 falls (23% of falls prompting medical care) generated significant injuries that dictated medical work-up and intervention. The injury spectrum included five facial/scalp lacerations (45%), three fractures (27%), two dental injuries (18%), and one shoulder injury (9%). The incidents that required medical intervention due to injuries accounted for 1.4% of the total number of memorable falls (Table III).

Table III. Distribution of Medical Interventions Following 48 Falls

Medical visit outcome	# of falls (n=48)	% of falls
Outcome unknown	2	4
No intervention	35	73
Normal physical exam, no medical work-up	19	40
Medical work-up	16	33
Medical work-up & need for intervention	11	23
Total	48	100

Thus, a total of 27 fall episodes (27/782, 3% of all falls) needed medical work-up and/or intervention. The falls that prompted medical work-up or intervention occurred at a younger age than the falls that did not (8.9 ± 11.0 vs 19.9 ± 8.8 months, $p<0.001$).

Table IV summarizes the nature of the fall, injury acquired and medical intervention needed for the most significant 11 falls (1.4% of all falls). Two of these 11 subjects (18%) fell from greater than three feet. In 84 falls that occurred from a distance of more than three feet (falls in

Table IV. Nature of the Fall, Injury Acquired and Medical Intervention Needed for the Most Significant 11 Falls

#	Nature of fall	Injury	Intervention
1	Fall onto cement from adult's lap	Skull fracture	None
2	Fall on face on a wooden floor while running	Broken tooth	Tooth extraction
3	Mother falling down stairs while carrying the child	Greenstick fracture of tibia	Cast
4	Fall from a table	Scalp laceration	Sutures
5	Fall down stairs	Tongue laceration	Minor surgery
6	Fall from a couch onto the corner of a coffee table	Laceration of skin near the corner of eye	Sutures
7	Fall from a bed	Fractured leg	Cast
8	Fall off bleachers, hitting a bolt mid-fall	Scalp laceration	Sutures
9	Tripped over a booster seat while walking	Chipped upper tooth	Tooth sealing
10	Fall while rocking in the chair and hit refrigerator	Superficial laceration of the face	Wound care
11	Fall from a bed	Hit shoulder	Chiropractic adjustment

vignette 1 and 3 on Table IV), only 2% (2/84) resulted in any injury, none of which involved neurological findings. Similarly, no neurological findings were noted to result from any of the falls from less than three feet.

Discussion

This study reveals that falls in children under two years of age are common but very rare in infants under four months of age, the age at which a child's safety is virtually wholly dependent on its caretakers. Most falls (69.4%) in this study occurred in toddlers while walking or running. The second most common type of fall occurred from beds/couches/chairs followed by falling downstairs, another important category. Medical care was sought in only 6% of all falls. When medical care was sought, the need for medical intervention was even rarer (1.4% of all falls). Medical work-up and intervention were more common in children who fell at younger ages, with the majority of the injuries involving the head, face, and mouth.

The findings of this study were consistent with the literature, where comparisons were possible. Most previous studies had been hospital-based, introducing referral bias since only a minority of accidents result in serious injury or hospital referral. Thus, the falls reported by most of the literature represent the tip of the iceberg in terms of childhood fall experiences[1,7-12].

Many authors have reported on falls experienced by infants. Warrington et al.[22] reported that 22% of 11,466 infants six months of age and younger had experienced 3,357 falls. However, they also concluded that only 5% of all falls were in infants less than four months of age and that most of the falls occurred between 5-7 months of age. In our study, 7.2% of all falls occurred when the children were less than seven months of age, which is comparable to what Warrington et al.[22] reported. Hennrikus et al.[13] also stressed the rarity of injuries due to accidental falls in infants younger than one year.

Agran et al.[7] also reported that injury due to falls rapidly increased with age beginning at ages three to five months and peaking at 15 to 17 months. Another study conducted on children who fell out of a bed, crib, chair, or wagon while hospitalized for other medical reasons reported that most of the falls were experienced by children one and two years of age[2]. These findings are consistent with the findings in our study, suggesting that it is indeed uncommon for very young infants to fall. This result is meaningful in light of the fact that the majority of victims of inflicted head trauma are one to six months of age and present with either no history of a fall, or a trivial fall. Thus, in children under two years of age, serious or fatal intracranial injury reportedly resulting from a household fall needs to be investigated meticulously to rule out inflicted trauma.

The most common mechanism of falling in our study was tripping while walking or running since the study population included toddlers. Other most common fall mechanisms included falling from beds/couches/chairs and stairway incidents. This is in contrast with the findings of Warrington et al.[22] who reported that falls

most commonly occurred from beds and settees by rolling off surfaces or by being dropped by caretakers. This is explained by the authors themselves by the fact that their study focused on a sample limited to infants less than six months of age. Agran et al.[7] reported different mechanisms for each three-month period of the first two years of life: being dropped from a height (0-2 months), other falls from battering (3-5 months), falls from furniture (6-8 months), falls from stairs (9-11 months) and falls from buildings (24-26 months) with incidence peaking at different ages. In our study, the most common mechanisms of fall included falls from furniture (0-9 months), falls from stairs (10-12 months), tripping while running/walking (13-18 months), and falls during play activities (19-24 months).

The injury spectrum caused by falls varies depending on the study sample and inclusion criteria. In our study, all memorable falls recalled by parents retrospectively were included. Only 6% of all fall episodes prompted seeking medical attention in this study, with warranted medical intervention in only 1.4% of all fall episodes. The most significant injuries in this study included one skull fracture, two lower extremity fractures, and two broken teeth. With due acknowledgement of the fact that not all fall experiences were recalled in detail, these figures support the rarity of severe injuries from household falls. This is consistent with Warrington et al.[22], who reported that most falls resulted in no injury and serious injuries were very rare. When fractures and other serious injuries occurred due to a household fall, they resulted predominantly from complex accidents, and therefore it was expected that a detailed circumstantial history would be available[6].

It has been suggested that falls from less than 10 feet result in predominantly trivial injuries, although falls of 4-5 feet have resulted in skull fractures[2,14-16]. Tarantino et al.[17] reported mainly minor injuries from short falls in infants. Most children who fell down stairways sustained minor injuries, involving mainly the head and neck[18]. Another study that focused on infants 10 months of age or younger with a history of a vertical fall from four feet or less reported that such falls tend not to result in significant injury, with most injuries involving a minor hematoma or a contusion with no intracranial hematoma[19]. This is in keeping with our data, where the majority of falls led to no serious injury. Plunkett[20], on the other hand, reported that fatal injuries are possible from short distance falls involving distances of less than five to six feet. He was able to recruit only 18 cases of fatal injuries from a database of more than 75,000 falls. These cases involved falls mostly in the playground setting with rotational acceleration falls from swings, very few of which were verified by neutral observers, and there were only four cases under two years of age. Thus, his results have been questioned with regards to how representative they are of household falls.

Eleven percent of all falls in our study occurred from a distance of more than three feet. Of these, only 2% resulted in mild/moderate injury. These figures are in accordance with the literature reports that falls from heights of even more than three feet in the household do not cause significant injuries[2,13,15,16,18]. The fact that none of the children seeking medical attention had any neurological symptoms is in support of the literature that trivial household falls do not cause significant, debilitating head trauma. Nimityongskul et al.[2] looked into household falls and reported that children one to two years of age fell mostly from one to three feet with no subsequent extremity or spine injuries. Most of the injuries were minor head and face injuries. That study concluded that severe injuries are extremely rare due to trivial falls.

Wang et al.[21] concluded that children suffering from falls from less than 15 feet were at the same risk for intracranial and abdominal injuries as those who fell from 15 feet or more. In that study, not only are height increments too large, age distribution was also not taken into consideration in arriving at this conclusion.

The strength of the present study is that our sample of falls was not restricted to medical referrals or use of medical services due to a fall. Thus, this study covered a larger number of falls experienced by children that would not have come to medical attention in hospital settings. However, the surveyed sample and spectrum of falls are still limited. For instance, the data obviously did not include falls considered too trivial to be recalled in detail or reported. The method of data collection also had limitations

due to its reliance on parental recall; hence, the time interval that elapsed between the accident and completion of the questionnaire may have influenced responses. It was constantly reported by informants that children fell "all the time". Respondents were asked to provide information on the most memorable incidents. Thus, if anything, this study more likely overestimates the need for medical assessment and intervention after household falls.

Future research to determine the full spectrum of childhood falls should take into consideration settings outside the home but which represent the household setting, such as day care facilities. Utilizing video surveillance methodology may enhance our epidemiological understanding of the full spectrum of early childhood falls.

Acknowledgements

This study was partially funded by Carver College of Medicine at the University of Iowa via medical student research project grants in 2003-2004 and 2004-2005 academic years. It was presented at the 19th San Diego Conference of Child Maltreatment in January 2005.

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