

Incidence and Risk Factors of Fall Injuries Among Infants

A Study in Greece

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Objective: To assess the incidence of fall injuries among infants in Greece, overall and by type of nursery equipment.

Design: Review of data from a large injury database.

Setting: The Emergency Department Injury Surveillance System in Greece.

Patients: A total of 2672 injured infants.

Interventions: Specially trained health visitors performed in-person interviews with the children's guardians, using a precoded questionnaire. The results of an independent survey of 777 mothers of noninjured children younger than 2 years attending the same emergency departments were used to allow quantification of the role of specific nursery equipment in the causation of infant fall injuries.

Main Outcome Measures: Annual rate of injury by falling in infants, overall and by cause.

Results: About 4400 infant fall injuries occur annually in Greece, corresponding to an annual incidence rate of 44 injuries per 1000 infants. The incidence of falls increases with increasing infant age. A high percentage of severe injuries was detected, most of them concussions (14.3%) and fractures (9.4%). Approximately 10% of infants with fall-related injuries required hospitalization. More than 36% of fall injuries involved nursery equipment. Infant walker use was associated with a higher incidence of falls (about 9 per 1000 infant-years), and these falls occasionally involved stairs and caused serious injuries. Infant bouncers, strollers, and changing tables were all associated with a similar incidence of falls (about 4 per 1000 infant-years).

Conclusions: Falls are a common cause of serious infant injuries, and nursery equipment is frequently involved in the injury-causing event.

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DURING THE PAST FEW DECADES, injuries have been recognized as a major cause of death and disability worldwide and as a factor responsible for a substantial morbidity among children of all ages.¹⁻³ A characteristic of injuries among very young children is that aspects of their normal behavior, eg, the natural curiosity or the physiologic development of motor skills, could be associated with an increased injury risk,⁴⁻⁹ especially in a nonfriendly environment or when inappropriate nursery equipment is used. Moreover, caretakers often show insufficient consideration for the risks linked to the developmental milestones and sometimes forget that they should be prepared for unexpected behavior on the part of the infants.¹⁰ Most fall-related injuries affect children during their early stages of de-

velopment, and they usually occur at home.¹¹

Falls are one of the most common causes of injuries among infants, and they have long been studied in relation to nursery equipment. Several studies have explored the role of specific types of nursery equipment, such as infant walkers and bouncers, in the causation of fall-related injuries.^{5,12-15} To our knowledge, however, the overall contribution of these consumer products in the etiology of infant falls has not been thoroughly investigated. The present study aimed to assess the incidence of fall-related injuries among infants in Greece, overall and by type of nursery equipment. The study was based on infant injury data retrieved from a large database that covered more than 300 000 injured persons presenting to the emergency departments of a network of collaborating hospitals.

METHODS

The Center for Research and Prevention of Injuries was established by the University of Athens and the Greek Ministry of Health for the investigation and prevention of injuries in Greece. In collaboration with 4 major hospitals across the country, a large database (the Emergency Department Injury Surveillance System [EDISS]) was developed and is continuously updated. The database covers all persons who have contacted the emergency departments of the collaborating hospitals for an injury of any type at any age. Two of these hospitals are located in the greater Athens area: the first is a major teaching pediatric hospital that covers about 29% of the underlying childhood population, in which population about 9250 infants are born on average each year.^{16,17} The second hospital, which was not included in this analysis, is an adult trauma hospital, one of the 2 in the greater Athens area. The other 2 hospitals are the regional (district) hospitals of Magnesia and Corfu counties and have almost full coverage of the underlying populations. In these regions, about 2825 infants are born on average each year, and childhood injuries have been estimated to represent about 2.2% of those occurring in the Greek child population outside the greater Athens area.^{16,17}

The focus of this investigation was on fall-related injuries among infants younger than 12 months who were brought for care in an emergency department. The study protocol was approved by the Ethics Committee of the University of Athens Medical School. During a 5-year period, from January 1, 1996, through December 31, 2000, 2672 infant fall-related injuries were recorded in the EDISS database. The rubrics used to retrieve and classify data were W0101 to W1999 of *International Classification of Diseases, 10th Revision*, of the World Health Organization coding manuals, describing the mechanism of injury. The data retrieved from EDISS have been collected by specially trained health visitors, who have interviewed in person the children's guardians, usually mothers, on the basis of a pre-coded questionnaire.¹⁷ The interviews took place in the emergency departments of the collaborating hospitals along with the child's medical examination by the attending physician. The EDISS questionnaire covers sociodemographic variables, the mechanism and the objects involved in the injury, type of injury and injured body part, supervision patterns, medical assessment of the injured child, and treatment provided. Because the health visitors who collaborate in our project are integrated into the systems of the collaborating hospitals, there have been essentially no refusals. All information is recorded in the EDISS computerized database.

To assess the frequency of use of the various types of infant nursery equipment in the underlying population, and thus derive equipment-specific incidence rates of infant fall injuries, a special survey was conducted in the spring of 2001 in the same hospitals in which injury data were collected. In this survey, mothers of 777 noninjured very young children (1 to 2 years old) who consecutively, during a 3-month period, contacted the ambulatory services of the collaborating hospitals for checkups or very minor ailments were interviewed about the frequency of use of nursery equipment throughout the infancy of their children. It is worth noting that both studies were based on the same population. The health visitors involved in EDISS performed this task with the use of pre-coded questionnaires covering the various types of nursery equipment. There were only 11 refusals among the 788 contacted women.

For the analysis, the injured infants were classified by age, sex, principal object involved in the event, and type of principal injury. Subsequently, we calculated the incidence of infant fall injuries by equipment per 1000 infant-years, taking into

account infant-years at risk in the underlying population and frequency of use of nursery equipment as estimated in the ad hoc survey. The number of infants at risk every year in the catchment areas was 12 075 (9250+2825). The study period was 5 years; therefore, the total infant-years at risk was 60 375. We multiplied this figure by the proportion of users of each specified type of nursery equipment. The incidence of falls by type of equipment (per 1000 infant-years) was calculated as the ratio of each nursery equipment-related number of fall injuries to the corresponding infant-years at risk. Because of overlapping person-time at risk during the 1 year of infant life and the joint contribution of more than one type of nursery equipment to an injury, the estimated figures per single equipment add to more than the total infant fall injuries from all nursery equipment. Throughout the analysis, SAS statistical software (SAS Institute Inc, Cary, NC) was used.

RESULTS

Table 1 shows the distribution of 2672 infants with fall injuries, of a total 4340 infants with injuries of any type, recorded in EDISS during a 5-year period, by demographic variables, main object involved in the event, and type of principal injury. With the use of the sampling ratios calculated for the EDISS sample¹⁷ (28.9% for childhood injuries in the greater Athens area and 2.2% for childhood injuries in the rest of Greece, under the assumption that the recorded injuries are representative of those occurring in the whole of Greece), it is estimated that about 4400 infant fall injuries occur annually in Greece, corresponding to an annual incidence rate of approximately 44 injuries per 1000 infants. As far as infant age is concerned, the infant population at risk can be assumed to be equally distributed across the three 4-month age intervals. Thus, the substantial increase in the frequency of falls among all infants with increasing age was statistically highly significant (0-3 months, 12.7%; 4-7 months, 33.3%; and 8-11 months, 54.0%; $P < .001$ from a goodness-of-fit χ^2 test with 2 *df*). There was also evidence of a slight excess of male infants among those with fall injuries. Among the infant fall injuries, 269 (10.1%) were sufficiently serious to require hospitalization. As expected, most of the serious injuries were concussions (14.3%) and fractures (9.4%), which required hospitalization in 17.3% and 61.7% of instances, respectively.

Among the 2672 infant fall injuries, 967 (36.2%) involved nursery equipment, mostly walkers (11.5%), strollers (8.8%), and bouncers (5.7%). Changing table-related infant falls required the highest hospitalization rate among the studied nursery items (17.1%). About half of the recorded infant fall injuries (54.7%) were related to home objects other than nursery equipment, mainly furniture (37.2%) or other immobile home structures (15.9%); of those, almost 1 in 10 required hospitalization. In 244 instances (9.1%) the caregivers reported that infants slipped and fell from their arms; 1 in 5 infants who slipped and fell required hospitalization, and 36 of them had a fracture.

Table 2 shows the incidence of falls among infants by type of most frequently used nursery equipment, highlighting their involvement in the causality of these types of injuries. As indicated, in the catchment areas of the 3 study hospitals, an average of 12 075 new deliveries are

Table 1. Distribution of 2672 Infants With Fall Injuries Recorded in EDISS Database During a 5-Year Period (1996-2000) by Demographic Variables, Main Object Involved in Event, and Type of Principal Injury

Variable	Fall Injuries, No. (%) (N = 2672)	Infants Hospitalized With Fall Injuries (n = 269)		
		No.	% of Total Hospitalized	% of All Fall Injuries in Category
Age, mo				
0-3	340 (12.7)	57	21.2	16.8
4-7	891 (33.3)	89	33.1	10.0
8-11	1441 (54.0)	123	45.7	8.5
Sex				
Male	1465 (54.8)	149	55.4	10.2
Female	1207 (45.2)	120	44.6	9.9
Object involved in accident				
Nursery equipment	967 (36.2)	91	33.8	9.4
Walker	308 (11.5)	30	11.1	9.7
Stroller	234 (8.8)	11	4.1	4.7
Changing table	76 (2.8)	13	4.8	17.1
High chair	66 (2.5)	5	1.9	7.6
Crib	85 (3.2)	6	2.2	7.1
Bouncer	152 (5.7)	19	7.1	12.5
Other nursery equipment	46 (1.7)	7	2.6	15.2
Human arms	244 (9.1)	52	19.3	21.3
Home furniture	994 (37.2)	84	31.3	8.5
Immobile structures	425 (15.9)	38	14.1	8.9
Outside home objects	42 (1.6)	4	1.5	9.5
Type of principal injury				
Concussion	381 (14.3)	66	24.6	17.3
Fracture	251 (9.4)	155	57.6	61.7
Open wound	431 (16.1)	3	1.1	0.7
Strain/dislocation	22 (0.8)	0	0.0	0.0
Contusion/abrasion	884 (33.1)	31	11.5	3.5
No identifiable injury	686 (25.7)	8	3.0	1.2
Other injuries	17 (0.6)	6	2.2	35.3

Abbreviation: EDISS, Emergency Department Injury Surveillance System (Greece).

Table 2. Estimation of Incidence of Infant Injuries Due to Falls From Nursery Equipment by Type of Equipment

Nursery Equipment	No. of Falls in EDISS (1996-2000)	Users in Population at Risk (777 Infants),		Infant-years at Risk by Indicated Equipment*	Incidence of Falls by Equipment per 1000 Infant-years
		No.	(%)		
Crib	85	705	(90.7)	54 760	1.6
Bouncer	152	482	(62.0)	37 433	4.1
Stroller	234	750	(96.5)	58 262	4.0
Walker	308	456	(58.7)	35 440	8.7
High chair	66	294	(37.8)	22 822	2.9
Changing table	76	243	(31.2)	18 837	4.0

Abbreviation: EDISS, Emergency Department Injury Surveillance System (Greece).

*The number of infants at risk in the catchment area was 12 075; study period, 5 years; total infant-years at risk, 60 375 multiplied by the proportion of users of the indicated nursery equipment from the respective row.

recorded every year. On the basis of this number and the fraction of users of specified nursery equipment, as ascertained from the mothers of 777 noninjured infants, the incidence of falls by equipment per 1000 infant-years can be estimated. Infant walker use was associated with the highest incidence of falls, and these falls frequently involved stairs and caused nonminor injuries (among these injuries, 8% were fractures, 20% were concussions, and 26% were open wounds). Infant bouncers, strollers, and changing tables were associated with a similar incidence of falls (about 4 per 1000 infant-years).

COMMENT

Falls among infants are responsible for a substantial fraction of infant morbidity and mortality, accounting for about 6 deaths annually per 1 million infants in the United States.¹⁸ In the 15 European Union member states, infant falls account for about 4 and 8 deaths annually per 1 million infants in northern and southern member states, respectively, whereas in the 10 new member states of the European Union, the corresponding figure is 7.¹⁹

The findings of our study indicate that almost two thirds of all injuries recorded among infants in Greece were due to falls. More than one third of these falls were associated with the use of nursery equipment. Another third of infant falls were related to home furniture and equipment, which implies either inappropriate use of these objects in infant care or lapses in parental supervision.

As has been pointed out by other authors, use of nursery equipment carries a significant risk of falls during infancy.^{5,6,8,12-15} In line with the literature, infant walkers tended to be associated with relatively high risk of an infant fall injury.^{6,8,20,21} Among the other objects in nursery equipment, infant bouncers, strollers, and changing tables were associated with a similar level of time-integrated risk (Table 2). However, attention should be focused on changing tables because they are generally used for shorter periods than bouncers or strollers and, thus, can be thought of as being more hazardous on an equal-time basis. It is evident that among the studied nursery items, changing table-related infant falls led more frequently to an injury that required hospitalization. This may be attributed to the fact that the changing table may be furniture height or may be placed on a piece of furniture, which may result in an infant fall from a considerable height. Cribs appear to be less risky, even though they are used for longer periods. Obviously, there are variations in both time of exposure to and risk from nursery equipment, so that our estimates are by necessity indications of average nursery equipment-related risk.

In 251 instances, the reported fall injury led to a fracture. Several studies have suggested that fractures in very young children may involve an element of physical child abuse.^{22,23} Whatever the true underlying reason, these ratios are comparable with those reported from other series of infant fall injuries.²⁴

Our study pointed to the significant role of nursery equipment in fall-related injuries among infants. Parents should be aware of the potential hazards when purchasing such products and always use them according to the manufacturer's instructions.^{25,26} The use of nursery items by infants should be under strict adult supervision. Leaving an infant on a changing table or other surface even for an instant without supervision may result in an injury, since infants who are left unsupervised can roll off and fall, especially if they are placed on an elevated surface.²⁵⁻²⁷ If parents decide to purchase a walker for their child, notwithstanding current recommendations to the contrary, they should avoid its use on wheels, and they should restrict access to any stairs with a gate.²⁵ Infants should always be securely fastened with a safety belt when placed in a high chair, a changing table, or any other similar equipment.²⁵⁻²⁸

Advantages of this investigation are its general population coverage, large sample size, and use of a standard protocol. Moreover, the use of a comparison sample allowed the estimation of exposures in the population at risk, making it possible to calculate the nursing equipment-specific incidence rates. This comparison sample may not have been optimal, because there can be no assurance that there was strict correspondence with the population at risk. None of the children in the "exposure" sample, however, had come to the ambulatory ser-

What This Study Adds

From data that can be referred to the general population, through use of proper sampling ratios, we estimated the overall incidence of infant injuries from falls to approximate 44 injuries per 1000 infant-years. Nursery equipment-related products accounted for more than one third of all fall injuries among infants, and the relative importance of various types of nursery equipment in the causation of infant fall injuries and hospitalizations in Greece was ranked.

vices with an injury, all of them belonged to the same catchment population as the injured infants, and no obvious bias could be identified. As is common in injury research, we were unable to jointly examine predisposing conditions and triggering events in the causation of the infant falls. In the same context, we were unable to disentangle any hidden child abuse cases from those reported as unintentional falls. The study sample in greater Athens covers only a fraction of the total person-time at risk, but the choice of hospital relied on administrative considerations, and there is no reason to believe that important selection bias may have been introduced. Compared with North American countries, a considerably higher proportion of injured infants were hospitalized, but this is a well-known phenomenon in Greece, and it is frequently attributed to the inadequate development of primary health care in this country and the overprotective attitude of Greek society toward children.^{29,30}

In conclusion, we were able to calculate the overall incidence and estimate the nursery equipment-specific incidence of infant falls in the population of Greece. We found that among nursery equipment, use of infant walkers and, to a lesser extent, infant bouncers, strollers, and even changing tables is associated with a nonnegligible risk of injury from infant falls. Diligent adult supervision, informed product selection, and simple environmental modifications can contribute to the reduction of fall-related injuries in infancy.

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