

## Etiologic factors in falls from height in pediatric cases

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### Abstract

**Objective** In this study, factors causing falls from height and precautions taken for their prevention were investigated.

**Methods** The study was carried out prospectively between June 2009 and June 2010. Patients under 18 years of age presenting at the emergency department of a university hospital, for whom the primary reason for admission was an accidental fall from a height of at least one meter, were included in the study. The demographic characteristics of the patients, the characteristics of the falls, and clinical features were recorded.

**Results** Data for 133 patients were evaluated. Among these patients, 72 (54.1%) were male; the median age was 4 (IQR 2–7). The most common fall site was a balcony (38%). Falls frequently happened in the spring and the summer. The mean fall height was  $2.9 \pm 2.5$  m, the median GCS score was 15 (IQR 14–15), and the median PTS was 10 (IQR 9–11). The fall heights was higher in patients who lost consciousness ( $p < 0.001$ ). Among the 95 patients who were 0–6 years old, it was found that about 55% were unaccompanied by their parents. The most common pathology in the patients was head trauma (63%), while 17.3% had multiple traumas.

**Conclusion** Since the vast majority of the fall cases were in the pre-school age group, most were due to falls from a balcony, and more than half of the cases were

unaccompanied by parents or caregivers, there are two issues that need to be addressed in relation to pediatric falls from height: family education and legal regulations considering child safety in the design of doors, windows, and balconies of buildings.

**Keywords** Fall from height · Trauma · Pediatric · Multiple trauma · Etiology

### Introduction

It has been known for many years that falls from height are among the most important causes of mortality and morbidity in childhood. It has long been realized that preventing falls is a better approach than relying on management strategies after they have happened [1]. However, in spite of this knowledge, falls remain the most common of childhood traumas. In a CDC report covering the years 2000–2006, annual emergency service admissions due to unintentional injuries to patients between the ages of 0 and 19 years were reported to be approximately nine million. Of these, 2.8 million admissions to emergency rooms were due to falls [2]. In a study investigating falls from all levels in all age groups in the southeast of our country, 449 (83.5%) of 538 patients were 19 years of age or younger [3]. In the USA between 2000 and 2007, 1,061 of 67,373 deaths due to trauma in the 0–17 age group occurred due to falls [4].

Falls, which are a serious health problem in the pediatric age group, can be minimized by taking the necessary precautions; more importantly, it is a preventable cause of trauma [2, 5–8]. In the study described in this paper, we aimed to determine the etiologic factors associated with childhood age falls, and to review information that can aid in deciding which precautions should be taken to avoid such falls.

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## Methods

The study was performed prospectively. Patients under 18 years of age who were admitted to the emergency medicine department of a university hospital between June 2009 and June 2010 due to falls from at least one meter high as the primary cause of admission were included in the study. Falls due to suicidal intention and patients or parents who did not give consent were excluded from the study. Demographic data, information about the falls, the Glasgow Coma Scale (GCS) score and the Pediatric Trauma Score (PTS), identified pathologies, the clinics that performed the follow-up, the length of hospital stay, and mortalities were recorded. The study was approved by the local ethics committee of our institution.

The collected data were analyzed using the SPSS (version 16.0) statistical software package. The descriptive statistics for the demographic characteristics, the time interval during which each fall occurred, the place of the fall, the site of the fall, the fall height, whether there was loss of conscious following the fall, the presence of parents during the fall, the GCS, and the PTS were all considered.

The chi-square test and the Mann–Whitney *U* test were used to compare variables for groups that did and did not lose consciousness, and between age groups. The relations between the GCS, the PTS, and the fall height were evaluated using Spearman's correlation analysis.

## Results

The number of trauma patients admitted to our clinic during the mentioned period who were under 18 years of age was 3,698; the number of these who had suffered falls was 637. Among these, 133 patients fitted the inclusion criteria and gave their consent to be included in the study. The parents of 21 patients did not give their consent to be included in the study, and 3 patients had attempted suicide, so they were not included in the study. Seventy-two (54.1%) were male; the median age was 4 (IQR 2–7). When the time periods during which the falls had occurred were investigated, they were found to have most frequently occurred between 16:01 and 20:00 hours (in 67 patients, 50.4%) and between the months of May and August (80 cases, 60.2%). Thirty-six (27.1%) of the fall cases were observed to have occurred at the weekend; there was no difference regarding the daily distribution ( $p > 0.05$ ). Ninety-one falls (68.4%) occurred in city centers (Table 1).

When the fall events were analyzed, the first three rows comprised falls from a balcony (51 cases, 38.3%), from a slide (18 cases, 13.5%), and from furniture (wardrobe, bunk bed, etc.; 14 cases, 10.5%). The mean fall height was  $2.9 \pm 2.5$  m in all age groups. Thirty-four cases (25.6%)

**Table 1** Distribution of the falls according to age, sex, time period, and location

|                    | <i>n</i> (%) |
|--------------------|--------------|
| Gender             |              |
| Male               | 72 (54.1)    |
| Female             | 61 (45.9)    |
| Age                |              |
| 0–6 years          | 95 (71.4)    |
| 7–17 years         | 38 (28.6)    |
| Hour of fall       |              |
| 08:01–12:00        | 16 (12.0)    |
| 12:01–16:00        | 36 (27.1)    |
| 16:01–20:00        | 67 (50.4)    |
| 20:01–00:00        | 14 (10.5)    |
| Day of fall        |              |
| Weekdays           | 97 (72.9)    |
| Weekend            | 36 (27.1)    |
| Month of fall      |              |
| January–April      | 30 (22.6)    |
| May–August         | 80 (60.2)    |
| September–December | 23 (17.2)    |
| Place of fall      |              |
| City center        | 91 (68.4)    |
| County seat        | 30 (22.6)    |
| Village            | 12 (9.0)     |

had fallen 3–5 m and 18 cases (13.5%) had fallen  $>5$  m (Table 2). The median GCS score for all cases was 15 (IQR 14–15), and the median PTS was 10 (IQR 9–11).

When the age groups were considered, 42 cases (44.2%) were 0–6 years old, who were in the first rank in terms of falls from a balcony; 9 cases (23.7%) who were 7–17 years old were in the first rank in terms of falls from a slide. Among falls that occurred in city and town centers, 38 cases (41.8%) and 12 cases (40.0%), respectively, were falls from a balcony, making it the most common fall site in these areas. A loss of consciousness was observed immediately after the fall in 15 cases (11.3%). Those who lost consciousness had fallen from significantly higher positions ( $p < 0.001$ ). Patients who lost consciousness displayed lower GCS and PTS scores ( $p < 0.001$  and  $p = 0.002$ , respectively) (Table 3). There was no difference between the age groups with respect to sex, loss of consciousness, and GCS score ( $p > 0.05$ ) (Table 4). There was a negative correlation between the fall height and the GCS or PTS score ( $r = 0.61$  and  $r = 0.63$ , respectively,  $p < 0.001$ ) (Figs. 1, 2). In 52 (54.7%) of the 95 patients aged 0–6 years (54.7%), no parent or caregiver was accompanying the child at the time of the fall.

Head trauma was recorded in 84 (63.2%) cases, and two or more system injuries were noted in 23 (17.3%) cases.

**Table 2** Fall sites and heights

|                             | <i>n</i> (%) |
|-----------------------------|--------------|
| Site of fall                |              |
| Balcony                     | 51 (38.3)    |
| Slides                      | 18 (13.5)    |
| Furniture                   | 14 (10.5)    |
| Stairs                      | 11 (8.3)     |
| Roof                        | 10 (7.5)     |
| Vehicle                     | 6 (4.5)      |
| Window                      | 6 (4.5)      |
| Wall                        | 6 (4.5)      |
| Others (tree, column, etc.) | 11 (8.3)     |
| Height of fall              |              |
| >1 to <2 m                  | 48 (36.1)    |
| >2 to <3 m                  | 33 (24.8)    |
| >3 to <5 m                  | 34 (25.6)    |
| >5 m                        | 18 (13.5)    |

**Table 3** Comparison of the patients who did and did not lose consciousness during the time of the event

|                    | Patients who lost consciousness<br>( <i>n</i> = 15) | Patients that did not lose consciousness ( <i>n</i> = 118) | <i>p</i> value |
|--------------------|-----------------------------------------------------|------------------------------------------------------------|----------------|
| Gender             |                                                     |                                                            |                |
| Male               | 7 (46.7%)                                           | 65 (55.1%)                                                 | 0.59           |
| Female             | 8 (53.3%)                                           | 53 (44.9%)                                                 |                |
| Age (years)        | 3.8 ± 3.1                                           | 5.3 ± 4.6                                                  | 0.14           |
| Height of fall (m) | 5.7 ± 4.6                                           | 2.5 ± 1.8                                                  | <0.001         |
| GCS                | 9.6 ± 5.0                                           | 14.8 ± 0.4                                                 | <0.001         |
| PTS                | 5.5 ± 5.3                                           | 10.2 ± 1.6                                                 | 0.002          |
| Death              | 6 (40.0%)                                           | 0 (0.0%)                                                   | <0.001         |

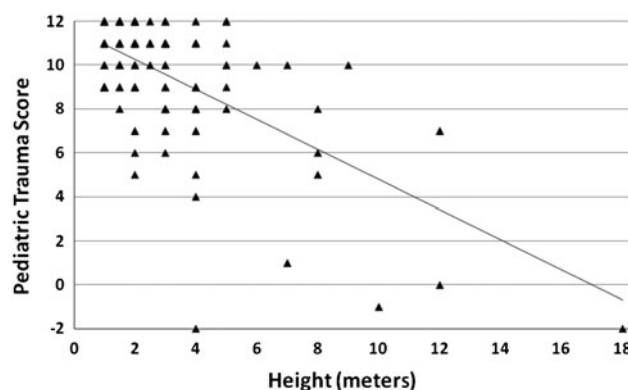
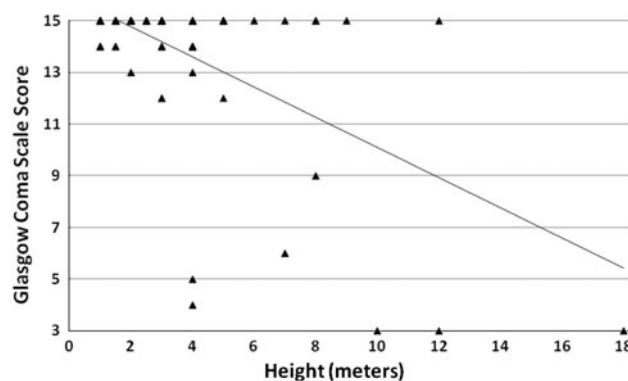
One hundred patients (75.1%) were discharged following initial treatment and clinical observation in the emergency room, while 27 (20.3%) were hospitalized in different disciplines. The median length of stay at the hospital was 2 (IQR 1–4) days; the mortality rate was 4.5% (Table 5).

## Discussion

Among all pediatric traumas, the rate of accidental falls is reported to be about 25–35% [7–10]. In a study of 0–19 year olds performed between 1999 and 2001, falls were the most common cause of hospitalization due to unintentional injuries [8]. In our study, the fall rate was found to be 17.2%. These rates differ for the following reasons: the accepted upper limit of the pediatric age varied with the

**Table 4** Comparison of the cases with respect to age group

|                       | 0–6 years old<br>( <i>n</i> = 95) | 7–17 years old<br>( <i>n</i> = 38) | <i>p</i> value |
|-----------------------|-----------------------------------|------------------------------------|----------------|
| Gender                |                                   |                                    |                |
| Male                  | 49 (51.6%)                        | 23 (60.5%)                         | 0.35           |
| Female                | 46 (48.4%)                        | 15 (39.5%)                         |                |
| Loss of consciousness |                                   |                                    |                |
| With                  | 13 (13.7%)                        | 2 (5.3%)                           | 0.16           |
| Without               | 82 (86.3%)                        | 36 (94.7%)                         |                |
| Height of fall (m)    | 2.9 ± 2.6                         | 2.6 ± 2.2                          | 0.37           |
| GCS                   | 14.1 ± 2.6                        | 14.8 ± 0.6                         | 0.12           |
| PTS                   | 9.4 ± 2.8                         | 10.7 ± 1.6                         | 0.007          |

**Fig. 1** Relationship between height of fall and PTS**Fig. 2** Relationship between height of fall and GCS

study (it ranged between 14 and 19 years), different limit values were accepted for the fall height, and there were differences in the geographical characteristics.

As also noted in a report published in 2008 by the Centers for Disease Control and Prevention, studies on pediatric falls have revealed that boys are more frequently exposed to trauma compared to girls [2, 4, 11–15]. In this study, the male/female ratio was found to be 1.2/1. This is

**Table 5** Pathologies found in the patients, and outcomes

|                                                                                            | <i>n</i> (%) |
|--------------------------------------------------------------------------------------------|--------------|
| Injury                                                                                     |              |
| Head trauma                                                                                | 84 (63.2)    |
| Thorax trauma                                                                              | 12 (9.0)     |
| Abdominal trauma                                                                           | 11 (8.3)     |
| Extremity fracture                                                                         | 19 (14.3)    |
| Multiple trauma                                                                            | 23 (17.3)    |
| Outcome                                                                                    |              |
| Discharged from hospital after the clinical observation period in the emergency department | 100 (75.2)   |
| Transferred to another ward                                                                | 27 (20.3)    |
| Death                                                                                      | 6 (4.5)      |

probably due to the fact that boys are more active at home, at school, and in the playground.

In our study, 71% of the patients were 0–6 years old. In a study by Lallier et al. [16], the mean age was 7.4, and 32% (15) of the cases were  $\leq 4$  years old. In another study that investigated falls from balconies, the 0–5 year-old age group was found to be at highest risk [17]. In a study where Mayer et al. [18] investigated falls that were followed up in intensive care, 84% of the cases were in the 0–5 year-old age group, and the unwitnessed fall rate was reported to be 42%. In a study performed in Paris of 67 cases, two-thirds of the cases were not under parental supervision during the time of the fall [19]. In the study of Istre et al. [20], it was reported that 85% of the supervising adults had their attention directed elsewhere when the child fell. Our study revealed that 54.7% of the 95 cases in the 0–6 year-old age group were not accompanied by parents or caregivers at the time of the fall. These results suggest that a lack of parent or caregiver supervision is an important factor in falls of pre-school age children.

The summer season is rather hot in our country, but the use of air conditioning in houses is rather uncommon for economic and cultural reasons. Therefore, balcony doors and windows are usually left open in the summer. Most of the falls in our study occurred between May and August. When the time intervals during which the falls occurred were considered, Istre et al. stated that falls from the balcony and windows usually occurred at meal times. On the other hand, they reported that no cases occurred between midnight and 07:00 hours [20]. Our results are almost the same as theirs. One-quarter of the cases occurred at noon, half of the cases occurred in the evening, and no cases occurred at night. In a study by Vish et al. [21], in which they investigated falls from windows, 47% were found to have occurred between 12:01 and 18:00 hours. The spring and summer months are the times when children are mostly

interested in the environment, balcony doors are left open, playgrounds are commonly used, and so it becomes more difficult to monitor children. Meal times may be a factor; during these times, the attention of parents or caregivers is shifted from the children to preparing the meal.

The frequencies of particular types of fall site differed between countries, and even between regions in the same country. A study in South Delhi noted that roofs, balconies, and furniture were the most common fall sites, while another study in USA stated that falls from stairs and playgrounds were the most frequent fall sites [7, 8, 22, 23]. In studies performed in the eastern regions, it was shown that about half of the cases had fallen from roofs; stairs were in second place [3, 24]. The most common fall sites in our study, in order of decreasing frequency, were balconies, slides, and furniture. These results suggest that the type of fall event show regional differences depending on socioeconomic and cultural levels.

In our study, the 0–6 year-old age group frequently fell from a balcony, while the 7–17 age group frequently fell from playground structures. In the literature, the frequency of falls from playground structures increased in the 5–12 year-old age group [8, 23, 25]. It has been stated that falls from balconies in 0–5 year-old children are more frequent than in other age groups [17, 18]. In pre-school children, the time spent at home is longer, and they are curious, active, and interested in the surrounding environment; all these factors may enhance the frequency of falls from balconies. On the other hand, children are always interested in playgrounds and entertainment areas. Therefore, it is of the utmost importance to design houses and playgrounds in such a way that pediatric injuries due to falls and other factors are prevented.

In studies of the pediatric and adult age groups, a direct relation between fall height and mortality and morbidity has been reported. The most frequently observed injury was reported to be head trauma [3, 13–15, 26, 27]. The results of our study are concordant with the literature in this respect. In the group that lost consciousness, the mean fall height was higher than in the conscious group, while a loss of consciousness was associated with significantly lower GCS and PTS scores. Two-thirds of the cases in this study had been exposed to head injuries. Also, 17.3% of the cases had multiple trauma, which shows the importance of this subject.

## Limitations

Our study has limitations; it was carried out in only one center, it had a limited number of cases, the fall height data were provided by parents or witnesses, there was a lack of information about the physical protective characteristics of

the fall sites and the ground onto which the children fell, and there was a lack of knowledge about the education levels of the families involved.

## Conclusion

The most frequent sites for falls are balconies, windows, stairs, playground structures, and roofs, although the relative frequencies vary with the residential area in which the fall takes place, as well as economic, social, and cultural factors. The great majority of falls are seen in pre-school age children, and a lack of supervision by parents and caregivers is one of the most important factors. In addition to instructing the parents, caregivers, and children, including protective elements in the design of sections such as doors, windows, and balconies in high buildings as well as playground structures would be beneficial. Large-scale studies of the precautions taken should be performed, and their results should be utilized to derive regional and national strategies as well as legal regulations.

**Conflict of interest** The authors declare that there is no actual or potential conflict of interest in relation to this article.

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