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PATTERNS OF INJURIES IN CHILDREN WHO FALL FROM A HEIGHT AS SEEN AT KENYATTA NATIONAL HOSPITAL

D. Kihiko, MBChB, MMed, Surgeon, Kitui District Hospital, P.O. Box 1121-00900, Kiambu, V. M. Mutiso, MMChB, MMed, Consultant Orthopaedic Surgeon and Lecturer, Department of Orthopaedic Surgery, College of Health Sciences, University of Nairobi, P.O. Box 19676-00202, Nairobi and J. G. Kiboi, MBChB, MMed, Consultant Neurosurgeon and Lecturer, Department of Surgery, College of Health Sciences, University of Nairobi. P.O. Box 30197-00100, Nairobi, Kenya

Request for reprints to: Dr. D. Kihiko, Kitui District Hospital, P.O. Box 1121-00900, Kiambu, Kenya

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D. KIHIKO, V. M. MUTISO and J. G. KIBOI

ABSTRACT

Objective: To describe injuries and outcomes among children who fall from a height

Design: Prospective, convenience hospital based study.

Setting: Paediatric surgical wards of Kenyatta National Hospital, Nairobi, from November 2006 to February 2007.

Subjects: Children aged 1-13 years who sustained injuries after falling from any height.

Results: Eighty children were recruited. There were 61 male (76%) and 19 female (24%), with an age range 1-13 years. Most injuries occurred at home (78.75%) after falling from buildings (33.75%), and were of mild-to-moderate severity. 13.4% sustained external haemorrhage, 16.5% sustained facial injuries, 25.2% sustained CNS injuries, 43.3% sustained various fractures, and 1.6% sustained abdominal trauma. The head and musculoskeletal systems were the most likely regions to be injured. The most common diagnoses were supracondylar fracture of humerus and mild head injury. No thoracic or pelvic fractures were recorded. Recovery was good in most instances.

Conclusion: Most children who sustain injuries after a fall from height do so after falling from a building. The most common types of injuries sustained were to the head and distal limbs, especially fractures. They were mostly of mild-moderate severity and recovery usually complete.

INTRODUCTION

As history taking is often difficult in children, awareness of the mechanisms and patterns of injury following a fall is useful. Falls are the leading cause of trauma admission to hospital in children (1). The injuries vary from minor injuries, which are a majority to severe multiple injuries (2). The mechanisms of injury is usually due to complex acceleration/deceleration forces applied suddenly to body organs.

Fractures such as torus (buckle) fractures and greenstick fractures occur especially in children. An X-ray of the suspected fracture site is diagnostic. Though most fractures will be minor (require casting only), some fractures such as those around the elbow require manipulation or surgical intervention (3). Some may be compound fractures requiring surgical toilet. In children, fractures of the spine are rare (4).

Multiple fractures should arouse suspicion of child abuse (5).

Most head injury patients will have minor trauma (Glasgow Coma Scale/ GCS score of 13-15). However, cerebral contusion, intracranial haemorrhage, concussion, cerebral oedema, cranial nerve palsies, skull fractures, and scalp lacerations may occur. A plain skull X-ray is routinely taken in all patients with head injuries, and can be supplemented with a CT scan (6). In abdominal injury, the liver is most commonly injured followed by the spleen, small and large intestines in that order. Focused abdominal sonography in abdominal trauma is the investigation of choice (1, 7, 8).

Despite the many studies conducted on childhood accidents, few of them specifically look at the spectrum of injuries sustained when one falls from a height. No study has been published in searchable media on childhood falls in Kenya (9).

MATERIALS AND METHODS

This study was a prospective hospital-based descriptive audit carried out over a period of three months (Nov 2006 - Feb 2007) at Kenyatta National Hospital Paediatric General Surgical Ward, Neurosurgical Ward, Orthopaedic Ward, and the ICU/HDU. Convenience sampling was used to pick participants. Children aged 1-13 years with a history of falling from height (defined as a vertical difference between any two levels more than one staircase), and requiring admission to the above named wards were recruited. Left out were children falling on level ground, those treated as outpatients, and those with unclear history, for example suspected battery. All guardians were required to give an informed consent. The Kenyatta Hospital Ethics Committee approved the research.

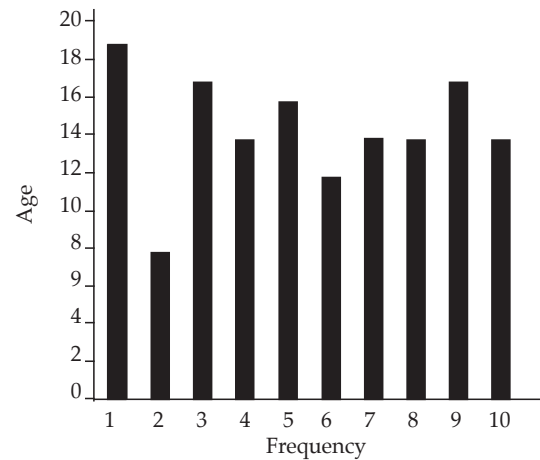
The participants were recruited on admission or were picked from the wards after admission. A structured questionnaire was used to collect data and is available from the corresponding author. After taking history relevant to the injury, all patients underwent a complete physical examination. Demographic data, history of the injury, physical examination findings and results of investigations carried out were recorded. All the diagnoses made were noted. Injury severity was graded according to the New Injury Severity Score (NISS) (10,11) and GCS for head injuries. The patients were followed up daily in the wards until they were discharged, and any new diagnosis was noted, especially after investigations. Results of any surgery carried out were recorded. Outcome of specific injuries at discharge was also recorded. The general outcome was grouped as return to normal (pre-injury state), mild residual disability (any disability that does not limit the activities of daily living), moderate (limits the activities of daily, living) and severe disability (vegetative state), or dead.

Data analysis: All were analysed manually and with use of the SPSS@ computer software. P-values less than 0.05 were taken as statistically significant.

RESULTS

A total of 80 patients were recruited, 61 male and 19 female (m:f ratio 3:1), with an age range of 1 year to 13 years as shown in Figure 1.

Figure 1
Age distribution.



Sixty two (77.5%) of them came from the areas surrounding Nairobi City, and 18(22.5%) came from outside Nairobi. Fifty (62.5%) hailed from slum areas. Sixty three (78.75%) sustained their injuries in a home environment, especially falls from buildings (balcony, window) 27 (33.75%). Other common causes were fall from playground equipment 17(21.25%), tree 12(15%), and others 15(18.75%). Almost all these falls were accidental except in one case where the father pushed the child down a stairway.

In the one to five year age group (n=41), most injuries were from falls related to a building and accounted for 23 (56%) of all injuries in the group. Children >5-10 year old (n=33) were more likely to be injured in the playground, 11(33.3%), or while climbing a tree, 9(27%). Ten year olds (n=6) were more susceptible to injuries from falling from a tree (3) or into a pit on the ground (2). The height of fall ranged from 0.25-9m (mean 2.35m).

Only 19(23.75%) of all children were under adult supervision when the accident occurred, and only 12 (15%) children received first aid. In these cases, eight of them received the first aid at school. Ten patients (12.5%) arrived in hospital within 30 minutes of being injured. Seventy one (88.75%) had arrived within two hours. Table 1 shows distribution of the various injuries encountered in the study.

Younger patients were more likely to suffer CNS injuries while older children tended to suffer MSS injuries (p=0.003). There was also an increase in severity score with increase in height of fall (p=0.002), as shown in figure two below. The relationship between the external causes of fall versus the region of the body most likely to be injured was not statistically significant (p=0.1881).

However, most CNS injuries were likely to result from injuries in the setting of a house, such as balcony, and most playground injuries affected the musculoskeletal system ($p=0.003$).

Table 1
Injuries encountered in the study

Injury (y=127)	Frequency	Percentage (of total injuries recorded)
Haemorrhage	17	13.4
-mild	12	9.4
-moderate	5	4
Facial injuries	21	16.5
CNS injuries	32	25.2
-mild head injury	25	19.7
-moderate head injury	5	4
-severe head injury	2	1.6
-spinal cord trauma-Frankel=D	2	1.6
Thorax	0	0
Abdomen	2	1.6
-blunt injury	1	0.8
-penetrating trauma	1	0.8
Pelvis	0	0
Fractures	55	43.3
-femoral	15	11.8
-supracondylar humeral	25	19.7
-humerus and clavicle	6	4.7
-radius and ulna	9	7.1
-other fractures	3	2.4
Total	127	100

Thirty three (41.25%) of the children needed treatment in theatre. These were musculoskeletal injuries, especially supracondylar fractures of the humerus. Only two cases of supracondylar fractures were managed conservatively compared to 21 that required operative management. The others were radial fractures (3), femoral neck fractures (2) and other humeral fractures (8).

There was a positive correlation between NISS score and outcome as shown in figure 3. Of the two cases that died in the wards, both had severe head injury with a GCS of eight.

The right-sided extremities were injured more frequently than the left 57(71.25%). No thoracic or pelvic injuries were encountered. The New Injury Severity Scores ranged from 1 to 41 (mean 11.5, median of 9). Most patients had low NSIS scores. 64 patients (80%) had a Glasgow Coma Score (GCS) of more 12, and only four patients (5%) had a score less 9. 6 (7.5%) patients sustained multiple injuries. Forty nine (61.25%) of the injuries healed with no residual disability, 29 (36.25%) healed with minor disability and two patients (2.5%) died from their injuries. The most frequent final diagnoses are shown in table 2.

Table 2
Most frequent diagnoses

	Type of injury	frequency	percent
1	Supracondylar fractures	25	19.7
2	Head injury: Mild	25	19.7
	HI: Moderate	5	4
	HI: Severe	2	1.6
3	Fractured femur	15	11.8
4	Fractured radius/ulna	9	7.1
5	Other fractures of the humerus	6	4.7
	Total	87	68.6

Figure 2
Height of fall versus NISS

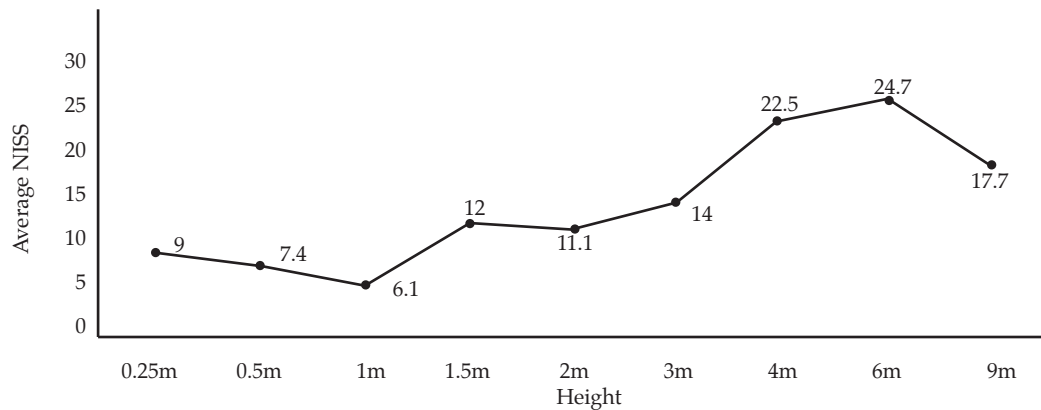
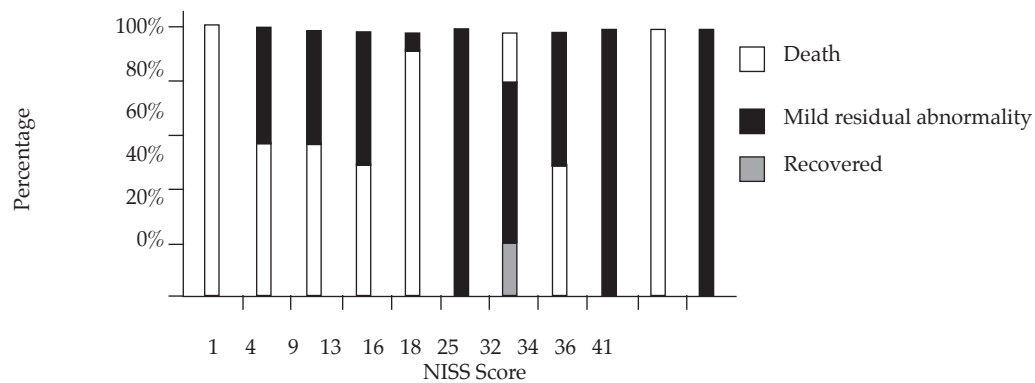


Figure 3
Relation between NISS and outcome



DISCUSSION

Most of the injuries occurred in densely populated areas. Overcrowding can result in poor supervisory standards for children at play. Most of these injuries occurred in a home setting, much more than those that took place at school or other places combined. This could be attributed to the fact that more supervision occurred at school than at home. Most schools are also designed to be accident proof. Many children who sustained injuries at home were pre-schoolers, also highlighting the accident proneness of this age group.

Fractures accounted for most of the injuries (43.3%). This compares well with the Australian data (12). These fractures were mostly femoral and humeral. Supracondylar fractures accounted for the lion's share of the injuries, taking 19.7% of all injuries. Children who fall from a height tend to fall on an outstretched hand and therefore the upper limb is injured more frequently. All upper limb fractures accounted for 32.3% of all injuries. No tibial or foot fractures were recorded. These are noted more in road traffic accident injuries and in other modalities

of injuries. Other long bone fractures could have been treated as outpatients and discharged, such as non-displaced distal radial fractures and the more frequent greenstick and torus fractures. There were no compound fractures encountered. Open fractures are mostly encountered in a setting with violent aetiology, such as road traffic accidents. Spinal fractures were relatively rare, with only two cases encountered. These were of mild Frankel grades.

CNS injuries were mostly mild head injuries. Severe head injury accounted for only four cases. The study recorded more cases of concussions (56.3%) than of intracranial haemorrhage, and one case of diffuse axonal injury. In this study, CT scans were performed sparingly. This can give a low pick rate for intracranial events. Other studies have recorded a higher incidence of head injuries (39%) than distal fractures (34%) (13). Mortality from fall-related injuries result from head trauma: The only two cases of mortality in this study had head injury. Kim *et al.* (14) identified 729 cases with a mortality rate of 1.7%, 50% dying from intracranial causes. In this study, facial injuries mostly coexisted with head injury.

Younger patients (1-5 years) were more likely to sustain head injuries, while older patients (>5 years) were more likely to sustain skeletal and abdominal trauma. This was a statistically significant finding. CNS and skeletal trauma accounted for 78.5% of all injuries recorded. In younger children, the head takes up a relatively higher mass than the rest of the body. Children will then tend to fall head first like a pendulum. Older children can fall with any part of the body leading.

No thoracic injuries or pelvic fractures were recorded in this study. This could be because of the small sample size that missed to pick these injuries. It would therefore be possible to pick out these injuries in a larger series of patients. For example, Khan *et al.* (15) looked at 260 bladder injuries and even encountered some cases of fall from a height.

The median NISS was nine. There was a direct relationship between height of fall with the severity of trauma and outcome. The mortality rate in this study was 2.5%, and that is comparable to other studies (16). In this study, all the mortality was due to head injury. No head injury required management in theatre. However, the decision to operate had no relationship with severity but rather the type of injury. For example, nearly all supracondylar humeral fractures required operation, while no head trauma was operated on.

Even in an environment with limited resources, good trauma outcomes could be achieved, especially with staff training in trauma care (Basic Life Support-BLS, Advanced Trauma Life Support-ATLS) (17). Similar results are reflected in other studies (16,18,19). It was noted that in almost all injuries occurring at home, no first aid was given. This could be because most housewives, househusbands and housemaids are not trained or are not conversant in first aid while most schoolteachers are. This can explain the differences in severity of injuries between home and school. The severity was also more in those children who presented much later after the incident.

Developing prevention mechanisms targeted at the population at risk, such as supervision during play, and childproofing homes can decrease the incidence of injuries from falls (2). Thus has been shown to be possible in developed countries, where falls from height are proportionately more important (20). It has also been documented that childhood trauma is preventable simply by better and closer supervision of children (21).

In conclusion, the study has demonstrated that patients with history of a fall are more likely to sustain closed fractures and head injury than any other type of injuries. Most injuries are of mild to moderate severity with almost all the children recovering fully. Intracranial trauma is usually the cause of mortality.

We therefore recommend the following: The clinician should actively seek these injuries. In cases of injuries not tallying with those described, further

history of other concomitant mechanisms of trauma should be sought, for example abuse, assault, RTA. Secondly, constant adult supervision of young children is mandatory. Homes and schools should be childproofed. Make it mandatory for teachers to undergo first aid courses. Buildings must also be childproof.

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