

Epidemiology and Patterns of Trauma in Children

Seyed Mokhtar Esmailnejad Ganji,^{1*} Behnam Baghianimoghadam,¹ Sekineh Kamali Ahangar,²

Maedeh Rikhtegar,³ Zahra Yusifzade Roshan,³ Zohreh Dehghani Hanife,³ and Behnaz Esmaeili³

¹Department of Orthopedics, Babol University of Medical Sciences, Babol, IR Iran

²Clinical Research Development Center, Shahid Beheshti Hospital, Babol University of Medical Sciences, Babol, IR Iran

³Babol University of Medical Sciences, Babol, IR Iran

*Corresponding author: Seyed Mokhtar Esmailnejad Ganji, Department of Orthopedics, Shahid Beheshti Hospital, Shahid Sargord Ghasemi St., Keshvari Sq., Babol, Mazandaran, IR Iran. Tel: +98-132265285, Fax: +98-132254392, E-mail: smsnganji@yahoo.com

Received 2015 November 18; Revised 2016 May 30; Accepted 2016 June 22.

Abstract

Background: Since trauma is the leading cause of death, hospitalization, and disability among children under 15, this study aimed to evaluate the epidemiology and patterns of trauma in children.

Methods: All trauma patients under 15 years of age who were hospitalized for trauma from 1999 to 2011 were enrolled in this cross-sectional study. After obtaining informed consent, demographic information, locations of the events, seasons of occurrence, times of arrival at the hospital, the transfer methods of the patients, types of trauma, anatomical locations of the trauma, hospitalization durations, and distances and times of the accidents before getting to a hospital were collected on a checklist. Then, SPSS software version 20 with a chi-squared test was used for statistical analysis.

Results: The study population consisted of 1,686 children with trauma injuries, 71.9% of whom were male, and 28.1% of whom were female. There was a significant correlation between age, sex, and duration of hospitalization among those patients presenting with certain mechanisms of trauma. The most injuries, with 620 (63.8%) cases, were reported in the lower extremities. After examining the relationships between the ages of the injured patients and the location of the upper extremities, multiple traumas, and abdominal injuries, significant correlations were found.

Conclusions: The results of the present study suggested that boys over 10 years of age were more susceptible to trauma and falling and other accidents are the most important causes of trauma identified among the children. The upper and lower extremities were also the most affected areas.

Keywords: Epidemiology, Children, Trauma

1. Background

Trauma is the most important factor causing mortality in human society, and it also is one of the main economic, social, and health problems in Iran (1). Trauma can be categorized into two types: penetrating and blunt. Blunt trauma is caused by falls, vehicular accidents, and physical conflicts (2). Penetrating trauma refers to physical trauma to a body part, either by impact, injury, or physical attack, which results in tears and cuts in the skin and other soft tissues. Blunt trauma refers to the initial trauma, from which develops more specific types of conditions such as contusions, abrasions, and lacerations, that can cause open or closed fractures. Open fractures are caused by both penetrating trauma and blunt trauma. Open fractures are sometimes caused by high-energy trauma, most commonly from an outside blow. In contrast, in open fractures by blunt trauma, the damaging force starts from the inside and extends outward (3, 2).

Approximately 15,000 deaths per year, and about 50% of all reported deaths among children, are due to trauma

(4, 5). Pediatric trauma is a major health problem in the U.S., and more than 10,000 children who are killed worldwide, and about 10% of all pediatric hospitalizations, are due to trauma (6); in developing countries, the leading cause of death among youth is trauma, and it is also a major cause of disability and health-related economic losses in these countries (7-9). Based on critical data recorded in 2005, trauma was the second leading cause of death from injury in Iran regardless of sex (10, 11). Despite improvements in education and safety issues, trauma is still the leading cause of death and disability in children who are 13 to 14 years-old (12). The common causes of death due to trauma in children are accidents, falls (falling from heights), sports accidents and injuries, assaults, burns, and drownings (2). It is necessary and essential to know the epidemiology and patterns of trauma in children in order to implement and evaluate preventive measures in developing countries (13). Lack of sufficient and adequate information and knowledge in this field motivated the present inquiry into investigating the epidemiology and patterns of trauma in children.

2. Methods

All trauma patients under 15 years of age who were hospitalized with different causes during 1999 - 2011 were enrolled in this cross-sectional study. After obtaining informed consent, the required information was collected in the form of a checklist that included: age, sex, mechanism of trauma (car accident, fall, conflict, entry of foreign object, burn, surgical trauma, animal attack, gunshot, falling object, or accident while playing (injury during games or sports, anatomical location of the trauma (limbs, head, face, abdomen, spine, chest, and genitals), the location of the accident (streets, homes, schools, parks, and other sites), season, time of arrival at the hospital, method of transport (ambulance, personal, or pass), duration of hospitalization, the distance from the scene of the accident to the hospital, and the time of the accident. SPSS software version 20 with a chi-squared test was used for statistical analysis. A value of $P < 0.05$ was considered significant.

3. Results

The study population consisted of 1,686 patients, including 1,212 male patients (71.9%) and 474 females (28.1%), and the male to female distribution of patients was 1 to 14. Boys ranged in age from 8.70 ± 3.85 years, and girls ranged in age from 7.36 ± 3.86 , respectively. The age and sex distribution of the patients is shown in Figure 1.

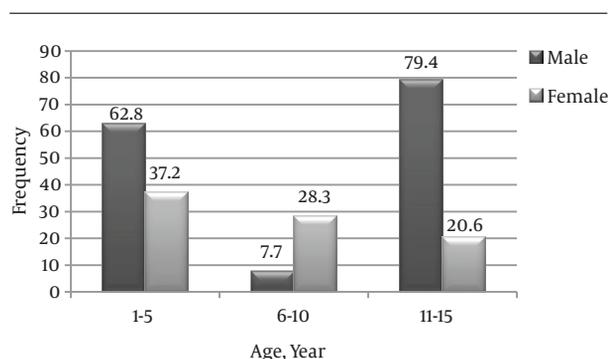


Figure 1. Distribution of Child Trauma Patients by Age and Sex During 1999 - 2011

Based on an analysis of the mechanisms of the traumas, falls occurred most often in 637 (37.8%), and surgical and gunshot traumas, each with four cases (0.2%), were allocated the lowest frequency. A statistically significant correlation was observed between age and mechanism of trauma ($P < 0.0001$; chi-squared test) (Table 1).

A statistically significant correlation was observed between sex and the mechanism of trauma ($P < 0.0002$; chi-squared test) (Table 2).

The lower extremities with 620 cases (63.8%), and the lowest number of damages was reported in the genitals with 36 cases (1.2%). After examining the correlation between the ages of the patients and abdominal trauma, upper limb injuries, injuries to genitalia, and multiple trauma injuries, significant correlation was observed ($P < 0.0001, 0.01, 0.01, \text{ and } 0.003$, respectively; chi-squared test) (Table 3).

After investigating the relationship between the mechanism of trauma and the duration of hospitalization, a significant correlation was seen ($P < 0.0001$; chi-square test) (Table 4).

In the summer 527 cases (31.3%) and in the winter 297 cases (17%) were seen, both having the highest and lowest frequencies, respectively. A total of 1,201 patients (71.2%) were transferred by private cars to the hospital, and 359 patients (21.3%) were transferred by ambulance. With respect to the location of the trauma's occurrence, it was determined that streets had the highest number cases with 814 (48.3%) and parks had the lowest number of cases with 60 (6.7%) (Table 5).

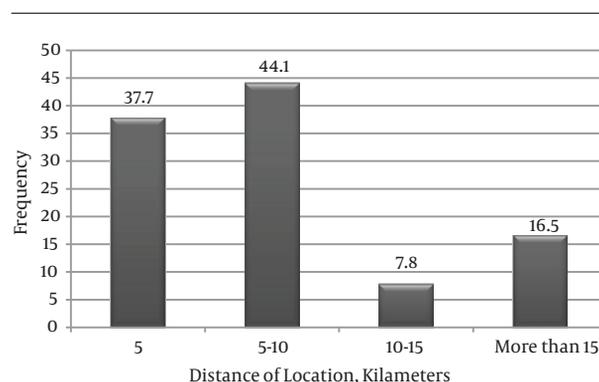


Figure 2. Distribution of Child Trauma Frequency According to Distance from the Hospital for Patients During 1999 - 2011

4. Discussion

Trauma is a major public health challenge throughout the world, which causes the death of millions of people and also imposes a huge financial burden on health systems (14). In the present study, the age group most at risk was those older than 10 years of age, which correlated with the studies of Javid (15) and Zargar (16) in Tehran (2002).

In this study, the incidence rate of trauma was more frequent among boys than girls. In Esfahan, a study conducted by Me'marzade et al. (2004 - 2007) (17) on 2,300 trauma children showed that the incidence rates of trauma were 66.7% for boys and 33.3% for girls, which was

Table 1. Distribution of the Mechanisms of Trauma for the Different Ages of Children Admitted During 1999 - 2011^a

Mechanism of Trauma	Age, y		
	1 - 5, No. (%)	6 - 10, No. (%)	11 - 15, No. (%)
Car accidents	107 (21.7)	190 (38.5)	196 (39.8)
Falls	215 (33.8)	229 (35.9)	193 (30.3)
Conflicts and assaults	1 (9.1)	1 (9.1)	9 (81.8)
Entries of foreign objects	98 (29.9)	103 (31.4)	127 (38.7)
Burns	6 (37.5)	5 (31.2)	5 (31.2)
Surgical trauma	1 (25)	1 (25)	2 (50)
Animal attacks	3 (27.3)	6 (54.5)	2 (18.2)
Shootings	-	-	4 (100)
Falling of heavy objects	22 (44)	12 (24)	16 (32)
Playing (sports) trauma	31 (23.5)	53 (40.2)	48 (36.4)

^aP < 0.001, chi-squared test.

Table 2. Distribution of the Mechanisms of Trauma Based on Sex of the Children Admitted During 1999 - 2011

Mechanism of Trauma	Sex, No. (%)	
	Male	Female
Car accidents	347 (70.4)	146 (29.6)
Falls	455 (71.4)	182 (28.6)
Playing (sports) trauma	108 (81.8)	24 (18.2)
Conflicts and assaults	11 (100)	-
Entries of foreign objects	238 (72.6)	90 (27.4)
Burns	10 (62.5)	6 (37.5)
Surgical trauma	2 (50)	2 (50)
Animal attacks	8 (72.7)	3 (27.3)
Shootings	4 (100)	-
Falling of heavy objects	29 (58)	21 (42)

similar to the results presented by Derakhshanfar et al. (18) and also consistent with those in our study. What this implies is that the main cause of trauma among boys may be their greater freedom in society.

The study showed that the main cause of trauma among children was falls. The study conducted by Me'marzade (2011) in Esfahan also reported that the main cause of childhood trauma was falling from heights (17). In a study conducted by Osifo et al. on 905 trauma children (2012) in Nigeria (19), and also in the study by Derakhshanfar (18), the main cause of trauma was due to accidents, which is not consistent with our results; this can be explained by the fact that the sample size of the latter study was low, in contrast with the other two studies which were

conducted in Iran (151 cases).

In the present study, organ injuries, especially those in the lower extremities, were reported as the most frequent. According to Adesunkanmi's study in Nigeria (20), the most injuries also occurred in the lower extremities, which matched the results of our study. The most damages to the neck and head were observed in Me'marzade's study in Esfahan (17) and Javid's study in Tehran (15), which are not consistent with our results.

In our study, most cases of trauma occurred in the street, with 814 cases (48.3%). In Me'marzade's study (17), most accidents were noted in the home or at school, which is not consistent with our results. In Javid's study (15) in Tehran (2006), the highest incidence rate of injuries oc-

Table 3. Distribution of Damaged Organs Based on Ages of the Children Admitted During 1999 - 2011

Damaged Organ	Age, y			P Value
	1 - 5, No. (%)	6 - 10, No. (%)	11 - 15, No. (%)	
Upper limb(s)	148 (30.6)	233 (38.8)	218 (36.2)	0.01
Lower extremity	180 (37.2)	220 (36.7)	220 (36.5)	0.97
Head	86 (17.8)	82 (13.7)	79 (13.2)	0.07
Face	104 (21.5)	127 (21.3)	99 (16.5)	0.5
Abdomen	2 (0.4)	8 (1.3)	28 (4.7)	< 0.0001
Genitalia	4 (0.8)	12 (2)	20 (3.3)	0.01
H.T.	48 (10.3)	42 (7.2)	40 (6.9)	0.09
Spine	7 (1.4)	23 (3.8)	18 (3)	0.05
Multiple traumas	44 (9.1)	80 (13.3)	96 (15.9)	0.003
Chest	5 (1)	7 (1.2)	14 (2.3)	0.18

Table 4. Distribution of Mechanisms of Trauma in Terms of the Differences in Hospitalization Duration for the Children Admitted During 1999 - 2011^a

Mechanism of Trauma	Duration of Hospitalization, d			
	0 - 10, No. (%)	11 - 20, No. (%)	21 - 30, No. (%)	31 - 88, No. (%)
Car accidents	352 (74.4)	78 (16.5)	31 (6.6)	12 (2.5)
Falls	536 (88.9)	54 (9)	10 (1.7)	3 (0.5)
Conflicts and assaults	10 (100)	-	-	-
Entries of foreign objects	290 (96)	10 (3.3)	2 (0.7)	-
Burns	15 (93.8)	1 (6.2)	-	-
Surgical trauma	3 (75)	1 (25)	-	-
Animal attacks	7 (63.6)	3 (27.3)	1 (9.1)	-
Shootings	4 (100)	-	-	-
Falling of heavy objects	43 (89.6)	4 (8.3)	1 (2.1)	-
Playing (sports) trauma	112 (89.6)	11 (8.8)	2 (1.6)	-

^aP < 0.001, chi-squared test.

curred on the streets, which is consistent with our results. Furthermore, in our study, the highest number of traumas occurred in the summer, which is consistent with Me'marzade's study in Esfahan (17) and Javid's study in Tehran (15). A lack of proper planning for children's leisure activities and more freedom to play in the streets during this season may have contributed to the increased rates of injuries and accidents at this time.

In our study, most of the trauma cases occurred between 12:00 and 20:00 pm. Since this time coincides with the closure of schools, educational facilities, offices, and factories, the increased traffic may account for the greatest amount of injuries. Thus, safety measures near schools when children are crossing the streets can be effective in

reducing the rate of injuries. In Zargar's study (16) on the epidemiology of traffic-related injuries among children in Tehran, most injuries were reported between 12:00 and 18:00pm, which is not consistent with our results.

The majority of the mechanisms of trauma, such as falls, were seen among boys, which may be due to cultural considerations in our society and the decreased presence of girls in risky areas. Most accidents occur among older children as well. This is because there an increased sense of liberation, playfulness, disobedience, and carelessness among those in this age group.

4.1. Conclusions

According to the results of this study, boys of more than 10 years of age are more exposed to trauma, and

Table 5. Frequency of Trauma in Terms of Different Seasons, the Transport of the Patients, and the Place of the Occurrence for Children Admitted During 2009 - 2011

Characteristics	Frequency	Percent
Different seasons		
Spring	506	30.1
Summer	527	31.3
Autumn	354	21
Winter	297	17.6
The transport of the patients		
Ambulance	359	21.3
Private car	1201	71.2
Passing	116	6.9
The location of the occurrence		
Street	814	48.3
Home	586	34.8
School	113	6.7
Park	60	6.7
Others	113	6.7

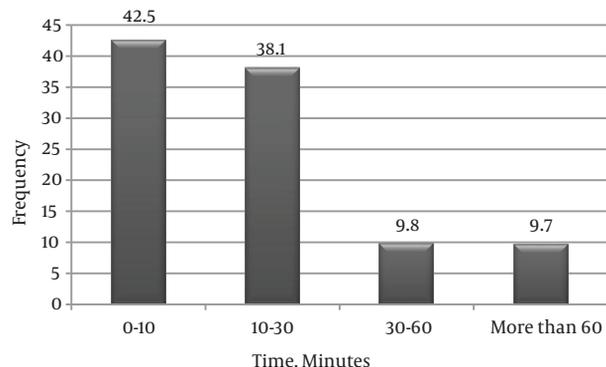


Figure 3. Distribution of Child Trauma Frequency According to Time Spent Reaching the Hospital for Patients During 1999 - 2011

falls and accidents were identified as the leading cause of trauma in children.

Acknowledgments

We express our sincere thanks to the orthopedic staff, archives staff, and Shahid Beheshti hospital clinical research development center for their technical support.

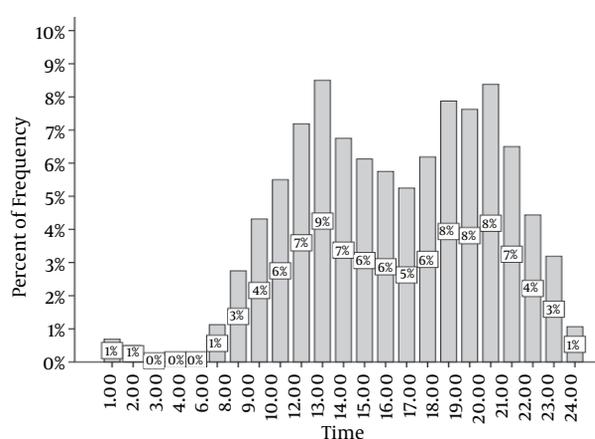


Figure 4. Distribution of Child Trauma Frequency Based on Time of Accident for Patients duRing 1999 - 2011

Footnotes

Authors' Contribution: Study concept and design, and performance of the surgeries: Seyyed Mokhtar Ismail Nezhad Ganji; analysis and interpretation of the data, Sekineh Kamali Ahangar; drafting of the manuscript: Seyyed Mokhtar Ismail Nezhad Ganji; critical revision of the manuscript for important intellectual content, Sekineh Kamali Ahangar; statistical analysis, Fortes, Mastoeni, Maedeh Rikhtegar, Zahra Yusufzade Roshan, Zohreh Dehghani Hanife; Behnaz Esmaili collected the patient's information.

Financial Disclosure: Authors who have no relevant financial interests are asked to provide a statement indicating that they have no financial interests related to the material in the manuscript.

Funding/Support: The authors of this article did not use any financial or material support.

References

1. Bijani M, Nikrooz L, Naghizadeh MM, Tavakkol Z. The Incidence of Chest Trauma in Patients Refer to Vali-Asr Hospital of Fasa: (Epidemiology of chest trauma) [in Persian]. *J Fasa Univ Med Sci.* 2013;3(3):285-9.
2. Amani F, Habibzade S, Rostami K. Characteristics of trauma patients admitted to hospital in the city of Ardabil Fatemi years 2007-2008 [in Persian]. *J Ardabil Univ Med Sci.* 2009;9(1):13-22.
3. Mablighi J, Yaghoobi A, Yaghoobi A, Ahmadi H, Borna L, Yaghoobi A. The pattern and factors associated with trauma victims treated at a hospital in Sanandaj in Year 2011 [in Persian]. *Sci J Kurdistan Univ Med Sci.* 2014;19:99-107.
4. Calleja Aguayo E, Delgado Alvira R, Elias Pollina J, Sainz Samitier A, Gonzalez Esgueda A, Esteban Ibarz JA. Our experience in the polytraumatized pediatric patient with criteria for admission to the ICU [in Spanish]. *Cir Pediatr.* 2010;23(2):107-10. [PubMed: 21298921].

5. Emejulu JK, Shokunbi MT. Aetiological patterns and management outcome of paediatric head trauma: one-year prospective study. *Niger J Clin Pract.* 2010;**13**(3):276-9. [PubMed: 20857784].
6. Cooper A, Barlow B, DiScala C, String D, Ray K, Mottley L. Efficacy of pediatric trauma care: results of a population-based study. *J Pediatr Surg.* 1993;**28**(3):299-303. [PubMed: 8468636] discussion 304-5.
7. Krug EG, Sharma GK, Lozano R. The global burden of injuries. *Am J Public Health.* 2000;**90**(4):523-6. [PubMed: 10754963].
8. Smith GS, Barss P. Unintentional injuries in developing countries: the epidemiology of a neglected problem. *Epidemiol Rev.* 1991;**13**:228-66. [PubMed: 1765113].
9. Murray CJ, Lopez AD. Mortality by cause for eight regions of the world: Global Burden of Disease Study. *Lancet.* 1997;**349**(9061):1269-76. doi: 10.1016/S0140-6736(96)07493-4. [PubMed: 9142060].
10. Guyer B, Gallagher SS. An approach to the epidemiology of childhood injuries. *Pediatr Clin North Am.* 1985;**32**(1):5-15. [PubMed: 3975097].
11. Danseco ER, Miller TR, Spicer RS. Incidence and costs of 1987-1994 childhood injuries: demographic breakdowns. *Pediatrics.* 2000;**105**(2):27. [PubMed: 10654987].
12. Avarello JT, Cantor RM. Pediatric major trauma: an approach to evaluation and management. *Emerg Med Clin North Am.* 2007;**25**(3):803-36. doi: 10.1016/j.emc.2007.06.013. [PubMed: 17826219].
13. Mohseni M, Khaleghdoost Mohammadi T, Kazemnejad Leili E, Adib M. Epidemiologic survey of trauma and associated factors in Guilan. *J Critical Care Nursing.* 2014;**7**(1):41-50.
14. Hemmati H, Kazemnezhad-Leili E, Mohtasham-Amiri Z, Darzi AA, Davoudi-Kiakalayeh A, Dehnadi-Moghaddam A, et al. Evaluation of chest and abdominal injuries in trauma patients hospitalized in the surgery ward of porsina teaching hospital, guilan, iran. *Arch Trauma Res.* 2013;**1**(4):161-5. doi: 10.5812/atr.7672. [PubMed: 24396771].
15. Javid M, Shahcheraghi G, Abdollahzadeh F, Ahmadi A, Farhadi A, Akasheh G. Road Traffic Injuries in Children. *J Bone and Joint Surgery Iran.* 2006;**4**(3):1-6.
16. Zargar M, Sayyar RB, Shadman M, Tarighi P. Epidemiology of traffic related injuries among children in Tehran: The necessity of implementation of injury prevention protocols. *J Wise Res.* 2002;**5**(2):77-82.
17. Memarzadeh M, Hoseinpour M, Sanjary N, Karimi Z. A study on trauma epidemiology in children referred to Isfahan Alzahra Hospital during 2004-7 [in Persian]. *J Kashan Univ Med Sci.* 2011;**14**(5):488-93.
18. Derakhshanfar H, Hatamabadi HR, Karimian K, Abdalvand A, Arhami Dolatabadi A, Shahrami A, et al. The prognosis of trauma among children and the factors contributing to it. *Health.* 2012;**4**(4):212-5.
19. Osifo OD, Iribhogbe PE, Ugiagbe EE. Epidemiology and pattern of paediatric and adolescent trauma deaths in a level 1 trauma centre in Benin city, Nigeria. *Injury.* 2012;**43**(11):1861-4. doi: 10.1016/j.injury.2011.07.016. [PubMed: 21820655].
20. Adesunkanmi AR, Oginni LM, Oyelami OA, Badru OS. Road traffic accidents to african children: assessment of severity using the injury severity score (ISS). *Injury.* 2000;**31**(4):225-8. [PubMed: 10719099].